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(54) Title: PSYCHOSIS PROTECTING NUCLEIC ACID, PEPTIDES, COMPOSITIONS AND METHOD OF USE

(57) Abstract

Psychosis protecting (PP) nucleic acids and encoded PP peptides and related proteins, and antibodies, anti-idiotype antibodies, and fragments thereto, for treatment, diagnosis and/or research related to the protection from psychosis such as schizophrenia or related disorders, or symptoms thereof, and expression products, compositions and methods therefor, including treatment of schizophrenia and related disorders, as well as transgenic non-human mammals expressing PP peptide or related protein encoding nucleic acids.

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PSYCHOSIS PROTECTING NUCLEIC ACID, PEPTIDES, COMPOSITIONS AND METHOD OF USE

This invention was made with Government support under MH 35976 and MH 08618 awarded by the National Institute of Mental Health. The Government thus has certain rights in the invention.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to the field of molecular biology and medicine, and more particularly to psychosis protecting (PP) nucleic acids and peptides involved in protection from psychoses and related disorders, as well as expression products, compositions thereof, and methods therefor, including detection, amplification, isolation and expression of such PP nucleic acids and PP peptides, as well as diagnostic and therapeutic methods using such PP peptides and their encoding PP nucleic acid.

Background of the Related Art

Psychoses, such as schizophrenia can be differentiated into two basic categories; those which are amenable to treatment, by means of conventional antipsychotic drugs, and those which are resistant to treatment, the latter usually being spoken of as "chronic" or "negative symptom" schizophrenia. Preclinical conditions of psychoses are also prevalent and could be subject to treatment if the degree of severity could be diagnosed in a standardized manner. These categories can, to some degree, be correlated with the relative balance of positive and negative symptomatology. The designation "negative (Bleulerian) symptomatology", although long known, has in recent years been used more routinely.

Treatment of psychoses and schizophrenia. Treatment of schizophrenia and other psychoses is commonly provided using the antipsychotics termed neuroleptic agents. Neuroleptic agents, regardless of their chemical structures, are pharmacologically active upon the dopamine receptor system, as dopamine antagonists. Many of these compounds, particularly the

phenothiazines, also have significant activity on other neurotransmitter systems, in particular various serotonin subtypes, particularly the 5-HT-2, and on muscarinic receptors, alpha-adrenoceptors, or histamine H-1 or H-2 receptors. The clinical use of neuroleptics has provided a means for treating patients suffering from psychotic disorders, including schizophrenia. Short-term use of neuroleptics is indicated in several types of exacerbations of schizophrenia. Continuous long-term use of neuroleptics is indicated, e.g., in primary indications involving schizophrenia as well as questionable indications such as chronic characterological disorders with schizoid, "borderline," or neurotic characteristics. See, e.g., Baldessarini, *Chemotherapy in Psychiatry*, Revised and Enlarged Edition, Harvard University Press, Cambridge, MA, (1985), the contents of which are entirely incorporated herein by reference.

Neuroleptics and Their Side Effects. Neuroleptics are also referred to as neuroplegics, psychoplegics, psycholeptics, antipsychotics and major tranquilizers, but are sometimes distinguished from non-neuroleptic psychotropics. Neuroleptics have also been characterized as agents that produce sedative or tranquilizing effects, and which also produce motor side effects, such as catalepsy or extrapyramidal symptomatology. Nonlimiting representative examples of neuroleptics include phenothiazine derivatives (e.g., chlorpromazine); thioxanthine derivatives (e.g., thiothixene); butyrophenone derivatives (e.g., haloperidol); dihydroindolone (e.g., molindone); dibenzoxazepine derivatives (e.g., loxapine); and "atypical" neuroleptics (e.g., sulpiride, remoxipride pimozide and clozapine). See Berstein *Clinical Pharmacology* Littleton, Mass.:PSG Publishing (1978); Usdin et al *Clinical Pharmacology in Psychiatry* New York:Elsevier North-Holland (1981); and Baldessarini, *supra*, (1985); which references are herein entirely incorporated by reference.

The long term use of all known anti-psychotics, including neuroleptics, has resulted in serious side effects, as set forth in Table I, such as persistent and poorly reversible motoric dysfunctions (e.g., tardive dyskinesia) in a significant

number of patients. For example, classical neuroleptic agents, as exemplified by the butyrophenones and phenothiazines, can, upon long-term administration, produce severe motoric symptomatology, termed tardive dyskinesia. These motor movements are uncontrollable and can range from relatively trivial manifestations to total debilitation. Tardive dyskinesia is usually reversible upon discontinuation of the chronic neuroleptic, if the drug is discontinued soon after symptoms of tardive dyskinesia appear. Otherwise symptoms may persist. Pharmacological intervention for treatment of tardive dyskinesia is only moderately successful. Such motor abnormalities are known to occur in as high as 10% of the patients who are maintained on these drugs for several years; the incidence is much greater in certain groups, such as middle-aged females.

The following Table I presents these and additional neurological side effects of neuroleptic anti-psychotic drugs.

TABLE I

Neurological Side Effects of Neuroleptic-Antipsychotic Drugs

Reaction	Features	Period of maximum risk	Proposed mechanism	Treatment
Acute dystonia	Spasm of muscles of tongue, face, neck, back; may mimic seizures; not hysterical	1-5 days	Dopamine excess? Acetylcholine excess?	Antiparkinsonism agents are diagnostic and curative (i.m. or i.v., then p.o.)
Parkinsonism	Bradykinesia, rigidity, variable tremor, mask-facies, shuffling gait	5-30 days (rarely persists)	Dopamine blockade	Antiparkinsonism agents (p.o); dopamine agonists risky?
Akathisia	Motor restlessness; patient may experience anxiety or agitation	5-60 days (commonly persists)	Unknown	Reduce dose or change drug low doses of propranolol;* antiparkinsonism agents or or benzodiazepines may help
Tardive dyskinesia spontaneous	Oral-facial dyskinesia; choreo-athetosis, sometimes irreversible, rarely progressive	6-24 months (worse on withdrawal)	Dopamine excess?	Prevention best; treatment unsatisfactory; slow remission
"Rabbit" syndrome	Perioral tremor (late parkinsonism variant?); usually reversible	Months or years	Unknown	Antiparkinsonism agents; reduce dose of neuroleptic

Malignant syndrome	Catatonia, stupor, fever, unstable pulse and blood pressure; myoglobinemia; can be fatal	Weeks	Unknown	Stop neuroleptic; antiparkinsonism agents usually fail; bromocriptine often helps; dantrolene variable; general supportive care crucial

a. There may be an increased risk of hypotension on interacting high doses of propranolol with some antipsychotic agents; clonidine may also be effective at doses of 0.2-0.8 mg/day, but carries a high risk of hypotension (Zubenko et al., *Psychiatry Res.* 11:143, 1984).

In addition, clozapine, although apparently capable of producing less motor side effects, can cause irreversible, potentially fatal agranulocytosis in a minority of patients administered the drug. Such serious side effects limit the use of clozapine to patients who are resistant to treatment with other neuroleptics.

These side effects are especially prevalent in geriatric populations, and adequate pharmacological treatment of these debilitating motoric dysfunctions is not currently available. This problem has been generally associated with long-term, clinical administration of these agents, including their use in the long term treatment of schizophrenia. There is thus a great need for alternative treatments for schizophrenia, including chronic schizophrenia, without toxic side effects of known agents used for such treatment, or whose long-term administration will not produce such toxic side effects.

Treatments proposed for schizophrenia. Anti-psychotic drugs, such as neuroleptics have been found to generally affect neuroreceptors, such as dopamine and serotonin receptors. Many of these receptors have been recently cloned and sequenced, such as the serotonin 5-HT1 and 5-HT2 (see, e.g., Leonard, *Int. Clin. Psychopharmacol.*, 7(1):13-21 (1992)) and dopamine receptors: D5 (Sunahara et al., *Nature*, 350:614-619 (1991)); D4 (Van Tol et al., *Nature*, 350:610-614 (1991)); D1 (Zhou et al., *Nature*, 347:76-80 (1990); Dearry et al., *Nature*, 347:72-76 (1990)); and rat D2 (Tourtellotte et al., *Neurochem. Res.*, 12:565-571 (1987); Bunzow et al, *Nature*, 33:783-787; Miller et al, *Biochem. Biophys. Res. Com.*, 166:109-112)).

Currently anti-psychotic agents (neuroleptics) are used for the treatment of schizophrenia and all other psychoses.

Proposed treatments involve the use of compositions containing peptides and proteins which may act as ligands for receptors or portions of receptors as well as other neural active peptides and analogs thereof. Examples of such compositions include neurotensin peptide analogs (WO 93/00359, Du Pont Merck Pharmaceutical Co. (1993)), tachykinin agonists (WO 92/22569, Fujisawa Pharmaceutical Co., LTD. (1992); EP 482 539, Fujisawa Pharmaceutical Co., LTD. (1992)), galanin agonists (WO 92/20709, Astra AB (1992)), neurokinin receptor and fragments (WO 92/16547, Children's Medical Center (1992); dopamine receptor agonist/antagonist peptides (WO 91/04271, BASF AG, (1991)), thyrotropin releasing hormone analogs (U.S. patent No. 5,098,888, Vincent et al (1992)), enkephalin like peptides (WO 90/00564, Research Corp. Techn., Inc. (1990); U.S. patent Nos. 4,684,620 (1987) and 4,518,711 (1985), Hruby et al; EP 050 828, Merck, Inc. (1984)), calmodulin binding peptides (U.S. patent No. 5,182,262, Hruby (1993)), cerulein peptides (U.S. patent No. 4,552,865, Fujino et al (1985)), and dopamine releasing protein (U.S patent No. 5,149,786, Marcus et al. (1992)).

Citation of documents herein is not intended as an admission that any of the documents cited herein is pertinent prior art, or an admission that the cited documents are considered material to the patentability of any of the claims of the present application. All statements as to the date or representation as to the contents of these documents is based on the information available to the applicant and does not constitute any admission as to the correctness of the dates or contents of these documents.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome one or more deficiencies of the related art.

It is another object of the present invention to provide a psychosis protecting gene and expression products thereof, such as psychosis protecting (PP) peptides or psychosis protecting nucleic acids that are expressed in normal people,

but not expressed in patients diagnosed with clinical schizophrenia or other psychoses.

It is a further object of the present invention to provide methods for detecting the relative lack of expression of a psychosis protecting gene in a mammal, having a maximum range of expression that correlates with at least one clinical symptom associated with a psychotic disorder. These symptoms of various psychoses include thought disorders, affectual blunting, delusions, hallucinations, anhedonic cognitive impairment.

It is yet a further object of the present invention to provide a means for diagnosing impending psychosis in individuals at risk for schizophrenia or other psychoses who do not express genes or DNA comprising a sequence corresponding to a PP peptide or related peptide or protein.

It is yet another object of the present invention to use a portion a nucleic acid sequence corresponding to a DNA sequence according to Figure 1 as a probe to obtain and/or sequence a full length gene as expressed in lymphocytes or other accessible tissues and in brain tissue from psychotic and normal individuals or animals.

Another object of the present invention is to use the gene fragment as described in Fig. 1 to identify the DNA that corresponds to a PP peptide or protein and to identify the full length DNA that represents an extension of the present gene fragment.

It is also an object of the present invention to make an animal model of psychosis or animals vulnerable to psychosis by inhibiting the expression of PP peptide related proteins in rats, mice or other non-human species. In one aspect, a transgenic experimental animal is provided which has been transformed by the gene carrying the nucleic acid sequences inhibiting the expression of PP peptide related proteins so as to obtain an animal model exhibiting psychotic symptoms and the

corresponding neurophysiology. One example of such an inhibiting nucleic acid sequence encoding an anti-sense nucleic acid which is complementary to the DNA sequence of Figure 1 (SEQ ID NO:1).

The present invention is also directed to a transgenic laboratory animal as a model of a psychotic disorder which is produced by inserting a PP peptide related protein inhibiting nucleic acid of this invention into a mouse or other suitable laboratory animal so that the animal displays psychotic symptoms corresponding to a known psychotic disorder. Such an animal model enables testing on non-humans of treatment and diagnostic methods for psychotic disorders, such as schizophrenia, schizoaffective disorders, paranoid disorders, and some mood disorders.

It is also an object of the present invention to enable genetic counselors to provide information about the risk of schizophrenia or other psychoses by determining whether the protective gene described herein is actively expressed in an individual at risk for psychosis.

It is also an object to provide methods for treating psychoses by providing expression or expression products of a psychosis protecting gene as therapeutic compounds, compositions and methods.

It is another object of the present invention to provide monoclonal antibodies, anti-idiotype antibodies, or fragments thereof, which specifically bind an epitope of a psychosis protecting peptide.

It is yet another object of the present invention to provide PP peptides, antibodies, anti-idiotype antibodies, compositions and methods that can be used in therapeutic and/or diagnostic applications for psychosis, due to their expected biological properties.

A further object of the present invention is to provide synthetic, isolated or recombinant peptides which are designed to inhibit or mimic various PPs or fragments thereof, which are effective for the treatment or diagnosis of symptoms relating to schizophrenia or other psychoses.

It is another object of the present invention to provide non-naturally occurring synthetic, isolated and/or recombinant PP peptides which are fragments and/or muteins of polypeptides encoded by a DNA sequence of Fig. 1 (SEQ ID NO:1), or at least one of SEQ ID NOS:8-17, which encoded PP peptides are expected to have therapeutic effects in psychotic patients and which are useful for providing diagnostic, therapeutic or research compounds, compositions and methods of use.

According to one aspect of the present invention, a synthetic or recombinant PP peptide is provided that has anti-psychotic biological activity and comprises a PP amino acid sequence of, e.g., at least a 3-141, or any range or value therein, such as but not limited to 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 95, 100, 110, 120, 130 or 140 amino acids, comprising an amino acid sequence substantially corresponding to at least one of the three possible translation reading frames of Figure 1 (SEQ ID NOS:2-4) or SEQ ID NOS:8-17. In a preferred embodiment, the peptide is (a) chemically synthesized and/or (b) obtained from a recombinant host cell or organism which expresses a recombinant nucleic acid encoding a PP peptide, as defined herein, and/or may be provided as a therapeutic or diagnostic nucleic acid.

In another aspect of the present invention, a PP composition is provided, comprising at least one PP peptide, or a pharmaceutically acceptable ester, ether, sulfate, carbonate, malate, glucuronide or salt thereof, the PP composition optionally further comprising a pharmaceutically acceptable carrier and/or diluent.

In still another aspect of the present invention, a method is provided for treating a subject suffering from symptoms associated with schizophrenia or any other psychotic disorder.

In a preferred embodiment, the PP peptide corresponds to an active portion of a protein encoded by the nucleic acid of Figure 1 (SEQ ID NO: 1), or SEQ ID NOS:8-17, wherein the method comprises administering an effective psychosis treating modulating amount of a PP peptide of the present invention. In

another preferred embodiment, the disease state is a psychiatric disorder related to schizophrenia or schizo-affective disorder, or any other psychotic disorder, see American Psychiatric Association, *Revised Manual of Diagnostic and Statistical Criteria for Psychiatric Disorders (DSM-III-R)*, American Psychiatric Assoc. Press, Washington, DC (1989), hereinafter "Criteria for Psychiatric Disorders" which is entirely incorporated herein by reference.

In another preferred embodiment, the PP composition is administered as a pharmaceutical composition to provide a PP peptide in an amount ranging from about 0.01 μg to 100 mg/kg, and also preferably, about 10 μg to 10 mg/kg. In another preferred embodiment, the administeration is by oral, intravenous, intramuscular, parenteral or topical administration, including mucosal administration to the nasal mucosa or the oral mucosa, by aerosol, nebulizer or drop administration as non-limiting examples.

Other objects of the invention will be apparent to skilled practitioners from the following detailed description and examples relating to the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows the approximate nucleotide sequence (SEQ IDNO:1) of a psychosis protecting gene of the present invention and the expected three possible translation amino acid sequences (SEQ ID NOS:2-4).

Figure 2A-C is a restriction map of the nucleotide sequence presented in Figure 1.

Figure 3 is a diagram depicting a vector pOKSC4c, restriction sites and promoters of the nucleotide sequence of Figure 1.

Figure 4 is a subtraction cloning scheme used to detect subtracted clones used to obtain a schizophrenia protection gene according to the present invention.

Figure 5A-B are pictorial representations of *in situ* autoradiographies showing (Fig. 5A) hybridization of a psychosis protecting gene of the present invention with cortex and medial

geniculate nuclei, including the CA1 to CA3 of Ammon's horn (hippocampus), with the interhinal, perihinal and temporal cortexes having higher signals; and (Fig. 5B) control showing absence of hybridization.

DETAILED DESCRIPTION OF THE INVENTION

Based on the discovery that normal monozygotic twins express a protein which is not expressed in corresponding schizophrenic monozygotic twins, and which psychotic preventing (PP) peptide related protein is only found to be expressed in areas of the cerebral cortex known to include neurotransmission involved in psychotic disorders, the present invention relates to PP peptides corresponding to functional domains of the normally expressed PP related protein. Such PP peptides are thus expected to be used to mimic naturally occurring, PP peptide related proteins, which are expected to have a protective and/or therapeutic effect on individuals suffering from symptoms relating to psychoses, such as schizophrenia or schizo-affective disorders or other psychoses (see, e.g., Criteria for Psychiatric Disorders', *supra*).

The basis of the present invention was discovered in studies of schizophrenia involving monozygotic twins where one twin has symptoms of the disease and the other twin is normal, which thus provides a "control" for the other twin. Estimates of concordance rates for schizophrenia in monozygotic twins vary, but are in the fifty percent range. Inasmuch as both twins presumably have identical genes (verified by DNA fingerprinting) and immunological markers, the clinical manifestations of the illness might be determined by other factors as well. If schizophrenia is of multifactorial etiology (i.e., having multiple gene and environmental components), the application of quantitative genetic analysis may be inappropriate in the elucidation of the molecular etiology of the illness. One alternative approach is to study gene expression in affected individuals and controls.

Thus the present invention involved the subtraction cloning of cDNA from mRNA of such monozygotic twins to determine

if a psychosis protecting gene was expressed in normal twins and not in psychotic twins. The discovery of such a PP peptide encoding gene, and confirmation of expression in the cortex where neurotransmission effects associtated with psychotic disorders has been determined, has provided a means to clone and express such PP related proteins and related or functionally similar PP peptides, as well as antibodies thereto, which are expected to be useful in the treatment, diagnosis and/or research involving psychotic disorders in humans and animals.

Accordingly, a "psychosis protecting peptide" or "PP peptide" of the present invention includes peptides having a "PP amino acid sequence" which can be obtained initially by using the sequence presented in Figure 1 (SEQ ID NO:1), or SEQ ID NOS:8-17, as a basis for designing polynucleotide probes to clone, sequence and express or synthesize PP related proteins and peptides occurring in normal individuals, and to a substantially lesser degree in individuals with psychotic disorders, such as polypeptides encoding in part by at least one nucleic acid comprising at least one nucleic acid sequence of SEQ ID NOS:8-17.

PP peptide nucleic acid probe detection of PP peptide epitope containing peptides or proteins. PP peptide nucleic acid probes may be used to detect RNA or DNA encoding PP peptide related or homologous proteins as a means to diagnose or prediagnose psychosis or related disorders, such as schizophrenia. Such nucleic acid probes may thus be used to quantitatively or qualitatively detect an RNA or DNA encoding a protein or peptide corresponding at least in part to a PP peptide in a sample or to detect presence such nucleic acids in biological fluids or cells which express such nucleic acid, *in vitro*, *in situ*, or *in vivo*, based on the teaching and guidance presented herein, without undue experimentation. The lack of, or presence of low concentrations of, nucleic acid encoding PP peptide related peptides and/or proteins is expected to correlate with psychoses and related disorders, such as schizophrenia.

Nucleic acid probe assays capable of detecting the presence of such a nucleic acid molecule, or proteins encoded therefrom, in a sample are well known in the prediction and diagnosis of disease. Nucleic acid detection assays can be predicated on any characteristic of the nucleic acid molecule, such as its size, sequence, susceptibility to digestion by restriction endonucleases, etc. Such a labeled, detectable probe can be used by known procedures for screening a genomic or cDNA library of a cell having a nucleic acid encoding a PP peptide related protein or peptide or as a basis for synthesizing PCR or other nucleic amplification probes for amplifying a cDNA generated from an isolated RNA encoding a target nucleic acid or amino acid sequence, as described herein.

A detectably labeled oligonucleotide probe of this sort can be a fragment of an oligonucleotide that is complementary to a polynucleotide encoding a PP peptide or fragment thereof. Alternatively, a synthetic oligonucleotide can be used as a target probe which is preferably at least about 10 nucleotide in length (such as 10, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, or 100-423 or more, or any combination or range therein, in increments of 1 nucleotide), such that the target probe is specific for the desired nucleic acid sequence to be detected, amplified or expressed. Preferably the nucleotide probe corresponds to at least a portion of a nucleic acid sequence presented in Figure 1.

Nucleic acids, or protein encoded thereby, to be detected by a method of the present invention, may be contained in samples isolated from any tissue sample of an animal subject or patient, such as blood, lymph, saliva, urine, CNS, amniotic fluid, skin, hair, feces, or any other tissue, and analyzed by hybridization to labeled probes. Such probes preferably hybridize to PP peptide-encoding nucleotide under high stringency conditions or medium stringency conditions, depending on the presence or possible presence of other non-target nucleic acids which also bind the probes specific for the target nucleic acids. For probe design, hybridization, and stringency

conditions, see, e.g., Ausubel *supra*, sections 6.3 and 6.4, and Sambrook et al, *supra*.

A wide variety of such labels have been used for labeling detectable probes, which can be used for labeling nucleic acid containing probes, as follows: (1) Kourilsky et al. (U.S. Patent 4,581,333), e.g., describe the use of enzyme labels to increase sensitivity in a detection assay; (2) radioisotopic labels are disclosed, e.g., by Falkow et al. (U.S. Patent 4,358,535), and by Berninger (U.S. Patent 4,446,237); (3) fluorescent labels of probes can be used (e.g., Albarella et al., EP 144914); (4) chemical labels of probes may be used (e.g., Sheldon III et al., U.S. Patent 4,582,789, Albarella et al., U.S. Patent 4,563,417); (5) modified bases in the probes may be used (e.g., Miyoshi et al., EP 119448); (6) a restriction enzyme sensitive label for differential restriction endonuclease digestion may be used (Saiki et al., *Biotechnology* 3:1008-1012, 1985), (7) an allele specific label using allele specific oligonucleotide probes may be used Saiki et al, *Nature* 324:163-166 (1986), Conner et al., *Proc. Nat'l Acad. Sci. USA*, 80:278 (1983), Holbeck and Nepom, *Immunogenetics* 24:251-258 (1986), Nepom et al, U.S. patent Nos. 5,039,606 and 4,971,902, and Whiteley et al, U.S. patent No. 4,833,750; (8) a ligase mediated label for ligase mediated gene detection (LMGD) using oligonucleotide ligation assays may also be used (Landegren, et al., *Science* 241: 1077-1080, 1988), and (9) a fluorescence energy transfer label for use in fluorescence resonance energy transfer (FRET), as disclosed, e.g., by Wolfe et al., *Proc. Nat. Acad. Sci. USA* 85: 8790-94 (1988).as non-limiting examples. See also, e.g., Ausubel et al, eds., *supra*; Sambrook, *supra*; Harlow, *supra*; and Coligan et al., *supra*, For related technologies and methods. See also, e.g., Ausubel, *supra*, at §§9.5.2 (selectable markers), §9.8 (RNA analysis), §§10.6-8 (detection of proteins), §§11.1-1.2 (immunoassays) and §§11.3-.16 (preparation and use of monoclonal, polyclonal and antipeptide antibodies for protein detection). The above references are all entirely incorporated herein by reference.

Accordingly, detection of a nucleic acid encoding a PP peptide related protein or peptide can be provided according to the present invention, based on the teaching and guidance presented herein, without undue experimentation. PP peptides of

PP peptides of the present invention can include fragments and/or mutein peptides encoded by nucleic acids corresponding to Figure 1 (SEQ ID NO: 1) or at least one of SEQ ID NOS:8-17, or amino acids encoded thereby (e.g., corresponding to SEQ ID NOS:2-4), or proteins encoded by at least one of SEQ ID NOS:8-17) of at least 10 amino acids in length, which have biological activity which modulates one or more symptoms associated with schizophrenia or schizo-affective disorders, such as delusions, hallucinations (particularly arbitrary), thought disorder and emotional blunting, which activity is measurable in *vitro, in vivo* or *in situ*, using known testing as screening assays. In the context of the present invention, "anti-psychotic biological activities" refers to having a detectable or measurable improved effect on at least one psychosis associated symptom, such as improved behavior, thought process, speech, thought content, improved perceptual abnormalities, affect, cognitive functions, and the like, as determined by known psychiatric evaluation techniques. See,., e.g., *Merck Manual, supra*, Chs. 133-136 and 140-143; and *Criteria for Psychiatric Disorders, supra*, which are entirely incorporated by reference herein.

Alternatively or additionally, screening may be carried out using the gene fragment as at least a 10 nucleotide sequence described in Fig. 1 (SEQ ID NO:1) or at least one of SEQ ID NOS:8-17) as a probe in Northern analysis or for dot blot or slot blot or other techniques for detecting specific RNA or DNA sequences, e.g., as substantially corresponding to at least one of SEQ ID NOS:8-17. Other methods for detecting the PP could also be used such as immunocytochemistry. Tissue sources of RNA could be lymphocytes or other accessible tissues, or any tissue capable of expressing a PP peptide or PP nucleic acid.

PP peptides of the present invention can be synthesized or recombinantly produced, or optionally purified,

to provide commercially useful amounts of PP peptides for use in therapeutic, diagnostic or research applications, according to known method steps, see, e.g., Ausubel et al, eds. *Current Protocols in Molecular Biology*, Greene Publishing Associates and Wiley Interscience, N.Y., N.Y. (1987, 1993); Harlow and Lane, *Antibodies: A Laboratory Manual*, Cold Spring Harbor Press (1988); Sambrook et al, *Molecular Cloning, A Laboratory Manual*, 2nd edition, Vols. 1-3, Cold Spring Harbor Press, (1989); Coligan et al., eds., *Current Protocols in Immunology*, Greene Publishing Associates and Wiley Interscience, New York, N.Y., (1992, 1993), which references are herein entirely incorporated by reference.

Additionally, PP peptides according to the present invention can be used to generate polyclonal and/or monoclonal antibodies, anti-idiotype antibodies thereto, or fragments thereof, which may used for diagnostic and/or therapeutic applications, according to known method steps, see, e.g., Harlow, *supra*, which is herein entirely incorporated by reference.

PP peptides or anti-idiotype antibodies (or fragments thereof) to PP peptides are expected to be useful to quantitatively or qualitatively modulate or prevent the development and/or symptoms associated with psychoses and related disorders, such that administration of PP peptides and/or anti-idiotype antibodies (or fragments thereof) may be used for research or therapeutic applications of the present invention.

Anti-PP antibodies (or fragments thereof) to PP peptides are also expected to be useful to quantitatively or qualitatively modulate or prevent the development and/or symptoms associated with psychoses and related disorders, such that administration of anti-PP peptide antibodies (or fragments thereof) may be used for diagnostic or research applications of the present invention.

Such PP peptides, (including PP fragments, substitution derivatives and anti-idiotype antibody fragments) of the present invention may be used to treat symptoms of, and

provide treatment for, pathologies related to psychose and related disorders. D_2 receptor-related psychotic disorders, including schizophrenia, now treated with neuroleptics, are non-limiting examples thereof.

The use of synthetic or recombinant PP peptides of the present invention can be preferable to the use of known drugs for schizophrenia and related disorders, e.g., which bind G-protein coupled receptors, such as neuroleptics that bind or inhibit the biological effect of binding to neuroreceptors as a non-limiting example. Such peptides are expected to have significantly less side effects than presently used drugs presently used for treating schizophrenia and related disorders, including neuroleptics, as they would structurally mimic naturally occurring PP peptides and/or modulate abnormal ligand binding. Thus, PP peptides are expected to have reduced side effects attributable to known foreign compound drugs, with less immunogenicity, and reduced potential for motoric side effects (e.g., extrapyramidal symptoms and/or tardive dyskinesia).

The present invention is also related to the production, by chemical synthesis or recombinant DNA technology, of PP peptides, preferably as small as possible while still retaining sufficient biological activity for protecting or treating the effect on patients having symptoms related to schizophrenia or other psychoses.

PP peptides of the present invention may include fragments of 5-10 to 50-150 amino acid fragments, or mutein sequences of PP peptides, e.g., as presented in Fig. 1 (SEQ ID NOS:2-4) including, e.g., homologs thereof having a homology of at least 80% with at least one PP peptide. See, e.g., Probst et al *DNA and Cell Biology* 11:1-20 (1992), which is entirely incorporated herein by reference.

Alternatively or additionally, a "psychosis protecting peptide" or "PP peptide" of the present invention includes peptides having a "PP amino acid sequence" which substantially corresponds to at least one 10 to 150 amino acid fragment and/or mutein of a polypeptide presented in Figure 1, wherein the PP peptide has homology of at least 80%, such as 81, 82, 83, 84,

85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99 or 100% homology to a peptide of figure 1 (SEQ ID NOS:2-4), while maintaining PP biological activity, wherein a PP peptide of the present invention is not naturally occurring or is naturally occurring but is in a purified or isolated form which does not occur in nature. Preferably, a PP peptide of the present invention substantially corresponds to at least a 10 amino acid portion of an amino acid sequence of Figure 1 (SEQ ID NOS: 2-4).

Also preferred are PP peptides correpsonding to proteins whose encoding nucleic acid hybridizes to polynucleotide probes corresponding to SEQ ID NO:1, wherein the PP amino acid sequence is 10 to 1000 amino acids in length, such as 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 300, 400, 500, 600, 700, 800, 900 or 1000 amino acids, or any value or range therein.

An amino acid sequence of, or nucleic acid sequence encoding, a PP peptide of the present invention is said to "substantially correspond" to another amino acid or nucleic acid sequence, respectively, if the sequence of amino acids or nucleic acid in both molecules provides PP peptides having biological activity that is substantially similar in amino acid sequence of a PP peptide, such that only one to a few amino acids differ in amino acid sequence. Additionally or alternatively, such "substantially corresponding" sequences of PP peptides include conservative amino acid or nucleotide substitutions, or degenerate nucleotide codon substitutions wherein individual amino acid or nucleotide substitutions are well known in the art.

Accordingly, PP peptides of the present invention, or nucleic acid encoding therefor, include a finite set of substantially corresponding sequences as substitution peptides or polynucleotides which can be routinely obtained by one of ordinary skill in the art, without undue experimentation, based on the teachings and guidance presented herein. For a detailed description of protein chemistry and structure, see Schulz, G.E. et al., *Principles of Protein Structure*, Springer-Verlag, New York, 1978, and Creighton, T.E., *Proteins: Structure and*

Molecular Properties, W.H. Freeman & Co., San Francisco, 1983, which are hereby incorporated by reference. For a presentation of nucleotide sequence substitutions, such as codon preferences, see Ausubel et al, *supra*, at §§ A.1.1-A.1.24, and Sambrook et al, *supra*, at Appendices C and D.

Conservative substitutions of a PP peptide of the present invention includes a variant wherein at least one amino acid residue in the PP peptide has been conservatively replaced by a different amino acid. Such substitutions preferably are made in accordance with the following list as presented in Table II, which substitutions may be determined by routine experimentation to provide modified structural and functional properties of a synthesized PP peptide molecule, while maintaining the psychosis treating or protecting biological activity.

Table II

Original Residue	Exemplary Substitution
Ala	Gly;Ser
Arg	Lys
Asn	Gln;His
Asp	Glu
Cys	Ser
Gln	Asn
Glu	Asp
Gly	Ala;Pro
His	Asn;Gln
Ile	Leu;Val
Leu	Ile;Val
Lys	Arg;Gln;Glu
Met	Leu;Tyr;Ile
Phe	Met;Leu;Tyr
Ser	Thr
Thr	Ser
Trp	Tyr
Tyr	Trp;Phe
Val	Ile;Leu

Alternatively, another group of substitutions of PP peptides of the present invention are those in which at least one amino acid residue in the protein molecule has been removed and a different residue inserted in its place according to the following Table III. The types of substitutions which may be

made in the protein or peptide molecule of the present invention may be based on analysis of the frequencies of amino acid changes between a homologous protein of different species, such as those presented in Table 1-2 of Schulz et al., *supra*, and Figs. 3-9 of Creighton, *supra*. Based on such an analysis, alternative conservative substitutions are defined herein as exchanges within one of the following five groups:

TABLE III

1. Small aliphatic, nonpolar or slightly polar residues: Ala, Ser, Thr (Pro, Gly);
2. Polar, negatively charged residues and their amides: Asp, Asn, Glu, Gln;
3. Polar, positively charged residues: His, Arg, Lys;
4. Large aliphatic, nonpolar residues: Met, Leu, Ile, Val (Cys); and
5. Large aromatic residues: Phe, Tyr, Trp.

Conservative amino acid substitutions according to the present invention, e.g., as presented above, are known in the art and would be expected to maintain biological and structural properties of a PP peptide after amino acid substitution. Most deletions and insertions, and substitutions according to the present invention are those which do not produce radical changes in the characteristics of the protein or peptide molecule. "Characteristics" is defined in a non-inclusive manner to define both changes in secondary structure, e.g. α-helix or β-sheet, as well as changes in physiological activity, e.g. in receptor binding assays.

However, when the exact effect of the substitution, deletion, or insertion is to be confirmed one skilled in the art will appreciate that the effect of the substitution or substitutions will be evaluated by routine screening assays, either immunoassays or bioassays to confirm biological activity. For example, a substituted PP peptide typically is made by site-specific mutagenesis of a PP peptide encoding nucleic acid, expression of the mutant nucleic acid in recombinant cell culture, and, optionally, purification from the cell culture, for example, by immunoaffinity chromatography using a specific antibody on a chemically derivatized column or immobilized

membranes or hollow fibers (to absorb the mutant by binding to at least one epitope).

A preferred use of this invention is the production, by chemical or recombinant DNA technology, of PP peptides, preferably as small as possible while still retaining schizophrenia or related disorder treating or preventing biological activity.

Antibodies, Anti-Idiotype Antibodies and Fragments Thereof for PP Peptides of the Present Invention, and Proteins and Peptides Related Thereto. This invention is also directed to antibodies ("Abs") or fragments thereof which bind at least one epitope specific for a PP peptide of the present invention. The present invention is also directed to methods using such an antibody or fragment to detect the presence of, or measure the quantity or concentration of, a protein or polypeptide sharing at least one epitope with a PP peptide, the protein or polypeptide being present in a cell, a cell or tissue extract, a biological fluid, an extract thereof, a solution, or sample, *in vitro*, *in situ*, or *in vivo*. Such methods provide a means to determine the extent, susceptibility or degree of psychosis or related disorders.

The term "anti-PP peptide antibody,"or "anti-PP peptide Ab", is meant to encompass any antibody or fragment which specifically binds to any PP peptide epitope, including polyclonal antibodies, monoclonal antibodies (mAbs), chimeric antibodies, anti-idiotypic (anti-Id) antibodies to antibodies specific for PP peptides of the present invention, as well as fragments, consensus polypeptides or chemical derivatives thereof (as presented herein for PP peptides). Such anti-PP peptide Abs may be produced by any known method steps, including hybridoma, recombinant or synthetic production techniques. An antibody is said to be "capable of binding" a molecule if it is capable of specifically reacting with the molecule to thereby bind the molecule to the antibody. The term "epitope" is meant to refer to that portion of any molecule capable of being bound by an antibody which can also be recognized by that antibody. Epitopes or "antigenic determinants" usually consist of

chemically active surface groupings of molecules such as amino acids, lipids or sugar side chains and have specific three dimensional structural characteristics as well as specific charge characteristics.

An "antigen" is a molecule or a portion of a molecule capable of being bound by an antibody which is additionally capable of inducing an animal to produce antibody capable of binding to an epitope of that antigen. An antigen may have one, or more than one epitope. The specific reaction referred to above is meant to indicate that the antigen will react, in a highly selective manner, with its corresponding antibody and not with the multitude of other antibodies which may be evoked by other antigens.

Polyclonal antibodies are heterogeneous populations of antibody molecules derived from the sera of animals immunized with an antigen. A monoclonal antibody contains a substantially homogeneous population of antibodies specific to antigens, which population contains substantially similar epitope binding sites.

Anti-PP peptide antibodies may be obtained by any method steps known to those skilled in the art. See, for example Kohler and Milstein, *Nature* 256:495-497 (1975); U.S. Patent No. 4,376,110; Ausubel et al, eds., *supra*; Sambrook, *supra*; Harlow, *supra*; and Coligan et al., *supra*, the contents of which references are incorporated entirely herein by reference. Such antibodies may be of any immunoglobulin class including IgG, IgM, IgE, IgA, GILD and any subclass thereof. A hybridoma producing a mAb of the present invention may be cultivated *in vitro*, *in situ* or *in vivo*.

Chimeric antibodies are molecules of which different portions are derived from different animal species, such as those having variable region derived from a murine mAb and a human immunoglobulin constant region, which are primarily used to reduce immunogenicity in application and to increase yields in production, for example, where murine mAbs have higher yields from hybridomas but higher immunogenicity in humans, such that human/murine chimeric mAbs are used. Chimeric antibodies and methods for their production are known in the art (Cabilly et

al, *Proc. Natl. Acad. Sci. USA* 81:3273-3277 (1984); Morrison et al., *Proc. Natl. Acad. Sci. USA* 81:6851-6855 (1984); Boulianne et al., *Nature* 312:643-646 (1984); Cabilly et al., *European Patent Application 125023* (published November 14, 1984); Neuberger et al., *Nature* 314:268-270 (1985); Taniguchi et al., *European Patent Application 171496* (published February 19, 1985); Morrison et al., *European Patent Application 173494* (published March 5, 1986); Neuberger et al., *PCT Application WO 86/01533*, (published March 13, 1986); Kudo et al., *European Patent Application 184187* (published June 11, 1986); Morrison et al., *European Patent Application 173494* (published March 5, 1986); Sahagan et al., *J. Immunol.* 137:1066-1074 (1986); Robinson et al., *International Patent Publication No.PCT/US86/02269* (published 7 May 1987); Liu et al., *Proc. Natl. Acad. Sci. USA* 84:3439-3443 (1987); Sun et al., *Proc. Natl. Acad. Sci. USA* 84:214-218 (1987); Better et al., *Science* 240:1041- 1043 (1988); and Harlow and Lane, *supra*. These references are incorporated entirely herein by reference.

An anti-idiotypic (anti-Id) antibody is an antibody which recognizes unique determinants generally associated with the antigen-binding site of an antibody. An Id antibody can be prepared by immunizing an animal of the same species and genetic type (e.g., mouse strain) as the source of the mAb with the mAb to which an anti-Id is being prepared. The immunized animal will recognize and respond to the idiotypic determinants of the immunizing antibody by producing an antibody to these idiotypic determinants (the anti-Id antibody). See, for example, U.S. patent No. 4,699,880, which is herein entirely incorporated by reference. The anti-Id antibody may also be used as an "immunogen" to induce an immune response in yet another animal, producing a so-called anti-anti-Id antibody. The anti-anti-Id may be epitopically identical to the original mAb which induced the anti-Id. Thus, by using antibodies to the idiotypic determinants of a mAb, it is possible to identify other clones expressing antibodies of identical specificity. Accordingly, mAbs generated against a PP peptide of the present invention may be used to induce anti-Id antibodies in suitable animals, such

as BALB/c mice. Spleen cells from such immunized mice are used to produce anti-Id hybridomas secreting anti-Id mAbs. Further, the anti-Id mAbs can be coupled to a immunogenic carrier such as keyhole limpet hemocyanin (KLH) or cationized bovine serum albumin and used to immunize additional BALB/c mice. Sera from these mice will contain anti-anti-Id antibodies that have the binding properties of the original mAb specific for a PP peptide epitope. The anti-Id mAbs thus have their own idiotypic epitopes, or "idiotopes" structurally similar to the epitope being evaluated.

The term "antibody" is also meant to include both intact molecules as well as fragments thereof, such as, for example, Fab and $F(ab')_2$, which are capable of binding antigen. Fab and $F(ab')_2$ fragments lack the Fc fragment of intact antibody, clear more rapidly from the circulation, and may have less non-specific tissue binding than an intact antibody (Wahl et al., *J. Nucl. Med.* 24:316-325 (1983)). It will be appreciated that Fab and $F(ab')_2$ and other fragments of the antibodies useful in the present invention may be used for the detection and quantitation of a PP peptide according to the methods disclosed herein for intact antibody molecules. Such fragments are typically produced by proteolytic cleavage, using enzymes such as papain (to produce Fab fragments) or pepsin (to produce $F(ab')_2$ fragments). See, e.g., Harlow, *supra*, Coligan, *supra*, Ausubel, *supra*. Additionally, synthetic or recombinant antibody fragments may be used which bind epitopes of PP peptides or related proteins.

Epitopes recognized by antibodies, and fragments and regions thereof, of the present invention may include 5 or more amino acids of at least one of SEQ ID NOS:2-4 or a PP peptide related protein provided according to the present invention using probes corresponding to, or complementary to a 10-421 base sequence of SEQ ID NO:1, which a topographical epitope of a PP peptide or related protein is recognized by, and specifically binds a anti-PP peptide antibody, fragments, and variable regions thereof.

Particular peptides which can be used to generate antibodies of the present invention include combinations of amino acids selected from at least 5-15 amino acids of at least one of SEQ ID NOS:2-4 as the alternative reading frame peptides encoded by SEQ ID NO:1, such as alternative reading frame peptides encoded by 15 to 421 bases of SEQ ID NO:1, which are combined to provide an epitope of a PP peptide or related protein that is bound by anti-PP antibodies, fragments and regions thereof.

The techniques to raise antibodies of the present invention to small peptide sequences that recognize and bind to those sequences in the free or conjugated form or when presented as a native sequence in the context of a large protein are well known in the art. Such antibodies include murine, murine human and human-human antibodies produced by hybridoma or recombinant techniques known in the art. See, Ausubel, *supra*, Harlow, *supra*, and Coligan, *supra*.

The identification of these peptide sequences recognized by mAbs of the present invention provides the information necessary to generate additional monoclonal antibodies with binding characteristics and therapeutic utility that parallel the embodiments of this application.

A PP-peptide specific murine, human or chimeric mAb of the present invention may be produced in large quantities by injecting hybridoma or transfectoma cells secreting the antibody into the peritoneal cavity of mice and, after appropriate time, harvesting the ascites fluid which contains a high titer of the mAb, and isolating the mAb therefrom. For such in vivo production of the mAb with a non-murine hybridoma (e.g., rat or human), hybridoma cells are preferably grown in irradiated or athymic nude mice.

Cell fusions for hybridoma formation of cells producing anti-PP peptide antibodies of the present invention may be accomplished by standard procedures well known to those skilled in the field of immunology (Kohler and Milstein, Nature 256:495-497 (1975) and U.S. Patent No. 4,376,110; Hartlow, E. et al., supra; Campbell, A., "Monoclonal Antibody Technology,"

In: Laboratory Techniques in Biochemistry and Molecular Biology, Volume 13 (Burdon, R., et al., eds.), Elsevier, Amsterdam (1984); Kennett et al., Monoclonal Antibodies (Kennett et al., eds. pp. 365-367, Plenum Press, NY, 1980); de St. Groth, S.F., et al., J. Immunol. Meth. 35: 1-21 (1980); Galfre, G. et al., Methods Enzymol. 73:3-46 (1981); Goding, J.W. 1987. Monoclonal Antibodies: Principles and Practice. 2nd ed. Academic Press, London, 1987) ;

Fusion partner cell lines and methods for fusing and selecting hybridomas and screening for mAbs are well known in the art (Hartlow, E. et al., supra; Kawamoto, T.et al., Meth. Enzymol 121:266-277 (1986); Kearney, J.F. et al., J. Immunol. 123:1548-1550 (1979); Kilmartin, J.V. et al., J. Cell Biol. 93:576-582 (1982); Kohler, G. et al., Eur. J. Immunol. 6:292-295 (1976); Lane, D.P. et al., J. Immunol. Meth. 47:303-307 (1981); Mueller, U.W. et al., J. Immunol. Meth. 87:193-196 (1986); Pontecorvo, G., Somatic Cell Genet. 1:397-400 (1975); Sharo, J., et al., Proc. Natl. Acad. Sci. USA 76:1420-1424 (1979); Shulman, M. et al., Nature 276:269-270 (1978); Springer, T.A. (ed), Hybridoma Technology in the Biosciences and Medicine, Plenum Press, New York, 1985; and Taggart, R.T. et al., Science 219:1228-1230 (1982)).

Alternatively, the antibodies my be produced by culturing hybridoma or transfectoma cells in vitro and isolating secreted mAb from the cell culture medium.

PP peptide epitope related protein/gene detection and diagnostic methods. Anti-PP peptide Abs and PP peptide encoding nucleic acid probes may be used according to methods of the present invention to diagnose patients having psychotic or related disorders, or to determine relative subclinical and clinical degrees of such psychotic disorders, or predisposition thereto. The present invention is based in part on the discovery that PP peptide expression products, such as RNA and/or PP peptides, have some protective effect on psychotic disorders in humans and possibly other mammals. Accordingly, the lack of, or presence of low concentrations of, PP peptide epitope containing peptides or proteins, or PP peptide encoding

nucleic acids, such as mRNA, is expected to correlate with subclinical, clinical and/or acute psychoses and related disorders, such as schizophrenia.

Therefore, diagnostic and detection methods of the present invention allow determination of the presence of, or susceptibility to, psychoses and related disorders in humans and mammals, using anti-PP peptide Abs and/or PP peptide encoding nucleic acid probes.

Antibody detection of PP peptide epitope containing proteins. Antibodies or fragments thereof having epitope binding sites specific for an epitope of a PP peptide, termed "anti-PP peptide antibodies," may be used to detect related or homologous proteins as a means to diagnose or prediagnose psychosis or related disorders, such as schizophrenia. Such antibodies or fragments may thus be used to quantitatively or qualitatively detect a protein or peptide corresponding at least in part to a PP peptide in a sample or to detect the presence of such proteins in biological fluids or cells which express such protein or peptide, *in vitro*, *in situ*, or *in vivo*, based on the teaching and guidance presented herein, without undue experimentation. The lack of, or presence of low concentrations of, PP peptide epitope containing peptides is expected to correlate with psychoses and related disorders, such as schizophrenia.

It will be appreciated that PP peptide antibodies, anti-idiotype antibodies and fragments thereof, such as Fab and $F(ab')_2$, may be used according to the present invention to detect and/or quantitate a PP peptide according to the methods disclosed herein for intact antibody molecules. Such fragments are typically produced by proteolytic cleavage, using enzymes such as papain (to produce Fab fragments) or pepsin (to produce $F(ab')_2$ fragments).

The antibodies of the present invention may be employed histologically, as in immunofluorescence or immunoelectron microscopy, for *in situ* detection of a PP peptide or a protein having psychosis protecting activity. Through the use of such a procedure, it is possible to determine not only

the presence of a PP peptide or a protein having psychosis protecting activity, but also its distribution on the examined tissue.

Additionally, the antibody of the present invention can be used to detect the presence of a soluble PP peptide or a protein having psychosis protecting activity, in a biological sample, such as a means to monitor the presence and quantity of a PP peptide or a protein having psychosis protecting activity, used for diagnosis of the extent, susceptibility or degree of psychosis or related disorder.

Such immunoassays, for detecting a PP peptide, or a protein having a PP peptide epitope, typically comprise incubating a biological sample, such as a biological fluid, a tissue extract, freshly harvested cells such as lymphocytes or leukocytes, or cells which have been incubated in tissue culture, in the presence of a detectably labeled antibody capable of identifying a PP peptide, and detecting the antibody by any of a number of techniques well-known in the art. See, e.g., Ausubel, *supra*, Harlow, *supra*.

The biological sample may be treated with a solid phase support or carrier (which terms are used interchangeably herein) such as nitrocellulose, or other solid support which is capable of immobilizing cells, cell particles or soluble proteins. The support may then be washed with suitable buffers followed by treatment with the detectably labeled PP peptide-specific antibody. The solid phase support may then be washed with the buffer a second time to remove unbound antibody. The amount of bound label on said solid support may then be detected by conventional means.

Such detection can be accomplished by any appropriate known method steps for detecting bound antibodies, such as enzyme linked immunosorbent assays (ELISA), isotope labeling, immunodiffusion assays, immunoaffinity chromotography, immunopreciptiation, protein staining, immunoblotting, iodination of proteins, biosynthetic labeling, or, e.g., immunofluorescence techniques employing a fluorescently labeled antibody (see below) coupled with light microscopic, flow

cytometric, or fluorometric detection. See, e.g., Coligan et al., *supra*, at Ch. 2, 5, 7 and 8; Ausubel, *supra*, and Harlow, *supra*, which references are entirely incorporated herein by reference.

By "solid phase support", "solid phase carrier", "solid support", "solid carrier", "support" or "carrier" is intended any support or carrier capable of binding antigen or antibodies. Well-known supports or carriers, include glass, polystyrene, polypropylene, polyethylene, dextran, nylon amylases, natural and modified celluloses, polyacrylamides, gabbros, and magnetite. The nature of the carrier can be either soluble to some extent or insoluble for the purposes of the present invention. The support material may have virtually any possible structural configuration so long as the coupled molecule is capable of binding to an antigen or antibody. Thus, the support or carrier configuration may be spherical, as in a bead, or cylindrical, as in the inside surface of a test tube, or the external surface of a rod. Alternatively, the surface may be flat such as a sheet, polymer test strip, etc. Preferred supports or carriers include polystyrene beads. Those skilled in the art will know many other suitable carriers for binding antibody or antigen, or will be able to ascertain the same by use of routine experimentation. See Coligan, *supra*, at Ch. 8-9.

The binding activity of a given lot of anti-PP peptide antibody may be determined according to well known method steps. Those skilled in the art will be able to determine operative and optimal assay conditions for each determination by employing routine experimentation. See, e.g., Harlow, *supra*, Coligan, *supra*, at Ch. 8. Other such steps as washing, stirring, shaking, filtering and the like may be added to the assays as is customary or necessary for the particular situation.

One of the ways in which a PP peptide-specific antibody, anti-idiotype antibody or fragment thereof, can be detectably labeled is by linking the same to an enzyme and use in an enzyme immunoassay (EIA), according to known method steps. See Harlow, *supra*. Coligan, *supra*, at Ch.2.

Detection may be accomplished using any of a variety of other immunoassays. For example, by radioactivity labeling the antibodies or antibody fragments, it is possible to detect R-PTPase through the use of a radioimmunoassay (RIA). A good description of RIA maybe found in *Laboratory Techniques and Biochemistry in Molecular Biology*, by Work et al., North Holland Publishing Company, NY (1978) with particular reference to the chapter entitled *"An Introduction to Radioimmune Assay and Related Techniques"* by Chard, incorporated entirely by reference herein. The radioactive isotope can be detected by such means as the use of a γ-counter, a scintillation counter or by autoradiography.

It is also possible to label an anti-PP peptide antibody, anti-idiotype antibody or fragment thereof, with a fluorescent compound. When the fluorescently labeled antibody is exposed to light of the proper wave length, its presence can then be detected due to fluorescence. Among the most commonly used fluorescent labelling compounds are fluorescein isothiocyanate, rhodamine, phycoerythrin, phycocyanin, allophycocyanin, o-phthaldehyde and fluorescamine, commercially available, e.g., from Molecular Probes, Inc. (Eugene, Ore.). See, e.g., Ausubel, *supra*, Harlow, *supra*, Coligan, *supra*, at Ch. 2 and 5.

The antibody can also be detectably labeled using fluorescence emitting metals such as ^{152}EU, or others of the lanthanide series. These metals can be attached to the antibody using such metal chelating groups as diethylenetriamine pentaacetic acid (EDTA). See, e.g., Ausubel, *supra*, Harlow, *supra*, Coligan, *supra*, at § 5.3

The antibody also can be detectably labeled by coupling it to a chemiluminescent compound. The presence of the chemiluminescent-tagged antibody is then determined by detecting the presence of luminescence that arises during the course of a chemical reaction. Examples of particularly useful chemiluminescent labeling compounds are luminol, isoluminol, theromatic acridinium ester, imidazole, acridinium salt and oxalate ester.

Likewise, a bioluminescent compound may be used to label the antibody of the present invention. Bioluminescence is a type of chemiluminescence found in biological systems in which a catalytic protein increases the efficiency of the chemiluminescent reaction. The presence of a bioluminescent protein is determined by detecting the presence of luminescence. Important bioluminescent compounds for purposes of labeling are luciferin, luciferase and aequorin.

An antibody molecule of the present invention may be adapted for utilization in a immunometric assay, also known as a "two-site" or "sandwich" assay. In a typical immunometric assay, a quantity of unlabeled antibody (or fragment of antibody) is bound to a solid support or carrier and a quantity of detectably labeled soluble antibody is added to permit detection and/or quantitation of the ternary complex formed between solid-phase antibody, antigen, and labeled antibody. See, e.g., Harlow, *supra*, and Coligan, *supra*, § 9.1.

Synthetic production of psychosis protecting peptides of the present invention. PP peptides and muteins can be synthesized according to known method steps. Chemical polypeptide synthesis is a rapidly evolving area in the art, and methods of solid phase polypeptide synthesis are well-described in the following references, hereby entirely incorporated by reference: (Merrifield, B., *J. Amer. Chem. Soc.* 85:2149-2154 (1963); Merrifield, B., *Science* 232:341-347 (1986); Wade, J.D. et al., *Biopolymers* 25:S21-S37 (1986); Fields, G.B., *Int. J. Polypeptide Prot. Res.* 35:161 (1990); MilliGen Report Nos. 2 and 2a, Millipore Corporation, Bedford, MA, 1987) Ausubel, *supra*, Sambrook et al, *supra*, Coligan, *supra*, Ch. 9, which references are all entirely incorporated herein by reference.

In general, as is known in the art, such methods involve blocking or protecting reactive functional groups, such as free amino, carboxyl and thio groups. After peptide bond formation, the protective groups are removed (or de-protected). Thus, the addition of each amino acid residue requires several reaction steps for protecting and deprotecting. Current methods utilize solid phase synthesis, wherein the C-terminal amino acid

is covalently linked to an insoluble resin particle large enough to be separated from the fluid phase by filtration. Thus, reactants are removed by washing the resin particles with appropriate solvents using an automated programmed machine. The completed polypeptide chain is cleaved from the resin by a reaction which does not affect polypeptide bonds.

More recently, the preferred "Fmoc" technique has been introduced as an alternative synthetic approach, offering milder reaction conditions, simpler activation procedures and compatibility with continuous flow techniques. This method was used, e.g., to prepare the peptide sequences disclosed in the present application. Here, the α-amino group is protected by the base labile 9-fluorenylmethoxycarbonyl (Fmoc) group. The benzyl side chain protecting groups are replaced by the more acid labile t-butyl derivatives. Repetitive acid treatments are replaced by deprotection with mild base solutions, e.g., 20% piperidine in dimethylformamide (DMF), and the final HF cleavage treatment is eliminated. A TFA solution is used instead to cleave side chain protecting groups and the polypeptide resin linkage simultaneously.

At least three different polypeptide-resin linkage agents can be used: substituted benzyl alcohol derivatives that can be cleaved with 95% TFA to produce a polypeptide acid, methanolic ammonia to produce a polypeptide amide, or 1% TFA to produce a protected polypeptide which can then be used in fragment condensation procedures, as described by Atherton, E. et al., *J. Chem. Soc. Perkin Trans.* 1:538-546 (1981) and Sheppard, R.C. et al., *Int. J. Polypeptide Prot. Res.* 20:451-454 (1982). Furthermore, highly reactive Fmoc amino acids are available as pentafluorophenyl esters or dihydro-oxobenzotriazine esters derivatives, saving the step of activation used in the tBoc method.

Recombinant production of psychosis protecting peptides of the present invention. Sequences available to use as a basis for PP peptide synthesis can be based on amino acid and/or nucleotide sequences corresponding to Figure 1 (SEQ ID NOS: 1-4). Recombinant production of PP peptides can be

accomplished according to known method steps. Standard reference works setting forth the general principles of recombinant DNA technology include Watson, J.D. et al., *Molecular Biology of the Gene*, Volumes I and II, The Benjamin/Cummings Publishing Company, Inc., publisher, Menlo Park, CA (1987); Darnell, J.E. et al., *Molecular Cell Biology*, Scientific American Books, Inc., publisher, New York, NY (1986); Lewin, B.M., *Genes III*, John Wiley & Sons, publishers, New York, NY (1989); Old, R.W., et al., *Principles of Gene Manipulation: An Introduction to Genetic Engineering*, 2d edition, University of California Press, publisher, Berkeley, CA (1981); Ausubel et al, eds., *supra*; Sambrook, *supra*; Harlow, *supra*; and Coligan et al., *supra*, the entire contents of which references are herein incorporated by reference.

A nucleic acid sequence encoding a PP peptide of the present invention may be recombined with vector DNA in accordance with conventional techniques, including blunt-ended or staggered-ended termini for ligation, restriction enzyme digestion to provide appropriate termini, filling in of cohesive ends as appropriate, alkaline phosphatase treatment to avoid undesirable joining, and ligation with appropriate ligases. Techniques for such manipulations are disclosed, e.g., by Ausubel et al, *supra*, and are well known in the art.

A nucleic acid molecule, such as DNA, is said to be "capable of expressing" a polypeptide if it contains nucleotide sequences which contain transcriptional and translational regulatory information and such sequences are "operably linked" to nucleotide sequences which encode the polypeptide. An operable linkage is a linkage in which the regulatory DNA sequences and the DNA sequence sought to be expressed are connected in such a way as to permit gene expression as PP peptides in recoverable amounts. The precise nature of the regulatory regions needed for gene expression may vary from organism to organism, as is well known in the analogous art. See, e.g., Sambrook, *supra* and Ausubel *supra*.

The present invention accordingly encompasses the expression of a PP peptide, in either prokaryotic or eukaryotic cells, although eukaryotic expression is preferred.

Preferred hosts are bacterial or eukaryotic hosts including bacteria, yeast, insects, fungi, bird and mammalian cells either *in vivo*, or *in situ*, or host cells of mammalian, insect, bird or yeast origin. It is preferred that the mammalian cell or tissue is of human, primate, hamster, rabbit, rodent, cow, pig, sheep, horse, goat, dog or cat origin, but any other mammalian cell may be used.

Further, by use of, for example, the yeast ubiquitin hydrolase system, *in vivo* synthesis of ubiquitin-transmembrane polypeptide fusion proteins may be accomplished. The fusion proteins so produced may be processed *in vivo* or purified and processed *in vitro*, allowing synthesis of a PP peptide of the present invention with a specified amino terminus sequence. Moreover, problems associated with retention of initiation codon-derived methionine residues in direct yeast (or bacterial) expression may be avoided. Sabin et al., *Bio/Technol.* 7(7): 705-709 (1989); Miller et al., *Bio/Technol.* 7(7): 698-704 (1989).

Any of a series of yeast gene expression systems incorporating promoter and termination elements from the actively expressed genes coding for glycolytic enzymes produced in large quantities when yeast are grown in mediums rich in glucose can be utilized to obtain PP peptides of the present invention. Known glycolytic genes can also provide very efficient transcriptional control signals. For example, the promoter and terminator signals of the phosphoglycerate kinase gene can be utilized.

Production of PP peptides or functional derivatives thereof in insects can be achieved, for example, by infecting the insect host with a baculovirus engineered to express at least one PP peptide by methods known to those of skill. See Ausubel, *supra*, at §§16.8-16.11.

In a preferred embodiment, the introduced nucleotide sequence will be incorporated into a plasmid or viral vector

capable of autonomous replication in the recipient host. Any of a wide variety of vectors may be employed for this purpose. See, e.g., Ausubel et al, *supra*, §§ 1.5, 1.10, 7.1, 7.3, 8.1, 9.6, 9.7, 13.4, 16.2, 16.6, and 16.8-16.11. Factors of importance in selecting a particular plasmid or viral vector include: the ease with which recipient cells that contain the vector may be recognized and selected from those recipient cells which do not contain the vector; the number of copies of the vector which are desired in a particular host; and whether it is desirable to be able to "shuttle" the vector between host cells of different species.

Preferred prokaryotic vectors known in the art include plasmids such as those capable of replication in *E. coli* (such as, for example, pBR322, ColE1, pSC101, pACYC 184, πVX). Such plasmids are, for example, disclosed by Maniatis, T., et al. (*Molecular Cloning, A Laboratory Manual*, Second Edition, Cold Spring Harbor Press, Cold Spring Harbor, NY (1989); Ausubel et al, eds., *supra*. *Bacillus* plasmids include pC194, pC221, pT127, etc. Such plasmids are disclosed by Gryczan, T. (In: *The Molecular Biology of the Bacilli*, Academic Press, NY (1982), pp. 307-329). Suitable *Streptomyces* plasmids include pIJ101 (Kendall, K.J., et al., *J. Bacteriol.* 169:4177-4183 (1987)), and streptomyces bacteriophages such as ϕC31 (Chater, K.F., et al., In: *Sixth International Symposium on Actinomycetales Biology*, Akademiai Kaido, Budapest, Hungary (1986), pp. 45-54). Pseudomonas plasmids are reviewed by John, J.F., et al. (*Rev. Infect. Dis.* 8:693-704 (1986)), and Izaki, K. (*Jpn. J. Bacteriol.* 33:729-742 (1978); and Ausubel et al, *supra*).

A gene or nucleic acid encoding for a naturally occurring protein having a PP peptide sequence can also be detected, obtained and/or modified, *in vitro*, *in situ* and/or *in vivo*, by the use of known DNA or RNA amplification techniques, such as PCR and chemical oligonucleotide synthesis. PCR allows for the amplification (increase in number) of specific DNA sequences by repeated DNA polymerase reactions. This reaction can be used as a replacement for cloning, all that is required is a knowledge of the nucleic acid sequence. In order to carry

out PCR, primers are designed which are complementary to the sequence of interest, such as a 10-140 base sequence as presented in Fig. 1 (SEQ ID NO:1). The primers are then generated by automated DNA synthesis. Because primers can be designed to hybridize to any part of the gene, conditions can be created such that mismatches in complementary base pairing can be tolerated. Amplification of these mismatched regions can lead to the synthesis of a mutagenized product resulting in the generation of a peptide with new properties (i.e., site directed mutagenesis). See also, e.g., Ausubel, *supra*, Ch. 16, and Coligan, *supra*, at §§ 10.20-10.23. Also, by coupling complementary DNA (cDNA) synthesis, using reverse transcriptase, with PCR, RNA can be used as the starting material for the synthesis of the PP gene without cloning. Detection of

PCR and other methods of amplification of RNA and/or DNA are well known in the art and can be used according to the present invention without undue experimentation, based on the teaching and guidance presented herein. Known methods of DNA or RNA amplification include, but are not limited to polymerase chain reaction (PCR) and related amplification processes (see, e.g., U.S. patent Nos. 4,683,195, 4,683,202, 4,800,159, 4,965,188, to Mullis et al.; 4,795,699 and 4,921,794 to Tabor et al; 5,142,033 to Innis; 5,122,464 to Wilson et al.; 5,091,310 to Innis; 5,066,584 to Gyllensten et al; 4,889,818 to Gelfand et al; 4,994,370 to Silver et al; 4,766,067 to Biswas; 4,656,134 to Ringold; and Innis et al eds. *PCR Protocols: A Guide to Method and Applications*) and RNA mediated amplification which uses anti-sense RNA to the target sequence as a template for double stranded DNA synthesis (U.S. patent No. 5,130,238 to Malek et al, with the tradename NASBA); and immuno-PCR which combines the use of DNA amplification with antibody labeling (Ruzicka et al., *Science* 260:487 (1993); Sano et al, *Science* 258:120 (1992); Sano et al., *Biotechniques* 9:1378 (1991)), entire contents of which patents and reference are entirely incorporated herein by reference.

PP peptide antibody purification. The expressed protein may be isolated and purified in accordance with known

method steps, such as extraction, precipitation, chromatography, affinity chromatography, electrophoresis, or the like. For example, the cells may be collected by centrifugation, or with suitable buffers, lysed, and the protein isolated by column chromatography, for example, on DEAE-cellulose, phosphocellulose, polyribocytidylic acid-agarose, hydroxyapatite or by electrophoresis or immunoprecipitation. Alternatively, the PP peptide or mutein thereof may be isolated by the use of anti-PP peptide antibodies. Such antibodies may be obtained by well-known methods, some of which are mentioned below. These antibodies may be immobilized on cellulose, agarose, hollow fibers, or cellulose filters by covalent chemical derivatives by methods well known to those skilled in the art. See, e.g., Harlow, *supra*, Coligan, *supra*, Ausubel, *supra*.

As discussed herein, PP peptides of the present invention may be further modified for purposes of drug design, such as for example to reduce immunogenicity, to prevent solubility and/or enhance delivery, or to prevent clearance or degradation.

Appropriate modification of the primary amino acid sequence of PP peptides of the present invention, obtained by mutagenesis or utilizing fragments, as described herein, will allow the creation of molecules which affect psychosis related symptoms than that exhibited by naturally psychosis protecting proteins. Small polypeptides that are provided according to the present invention which polypeptides maintain psychosis protecting activity, are expected to have two advantages over larger polypeptides. These advantages include (1) greater stability and diffusibility, and (2) less immunogenicity.

Pharmaceutical Preparations and Administration

Preparations of PP peptides for parenteral administration include sterile aqueous or non-aqueous solutions, suspensions, and emulsions, which may contain auxiliary agents or excipients which are known in the art. Pharmaceutical compositions such as tablets and capsules can also be prepared according to routine methods.

By the term "protection" from infection or disease as used herein is intended "prevention," "suppression" or "treatment." "Prevention" involves administration of a PP peptide or anti-idiotypic antibody *prior to the induction* of the disease.

"Suppression" involves administration of the composition *prior to the clinical appearance* of the disease.

"Treatment" involves administration of the protective composition *after the appearance* of the disease. It will be understood that in human and veterinary medicine, it is not always possible to distinguish between "preventing" and "suppressing" since the ultimate inductive event or events may be unknown, latent, or the patient is not ascertained until well after the occurrence of the event or events. Therefore, it is common to use the term "prophylaxis" as distinct from "treatment" to encompass both "preventing" and "suppressing" as defined herein. The term "protection," as used herein, is meant to include "prophylaxis."

At least one PP peptide, antibody or anti-idiotypic antibody of the present invention may be administered by any means that achieve their intended purpose, for example, to treat PP related pathologies, such as psychotic disorders, including schizophrenia using a PP peptide alone or preferably in the form of a pharmaceutical composition.

For example, administration of such a composition may be by various parenteral routes such as subcutaneous, intravenous, intradermal, intramuscular, intraperitoneal, intranasal, transdermal, or buccal routes. Alternatively, or concurrently, administration may be by the oral route. Parenteral administration can be by bolus injection or by gradual perfusion over time.

A preferred mode of using a PP pharmaceutical composition of the present invention is by intravenous or parenteral application.

A typical regimen for preventing, suppressing, or treating schizophrenia related symptoms or symptoms of other psychoses, comprises administration of an effective amount of a

PP peptide administered over a period of one or several days, up to and including between one week and about 24 months.

It is understood that the dosage of a PP peptide of the present invention administered *in vivo* or *in vitro* will be dependent upon the age, sex, health, and weight of the recipient, kind of concurrent treatment, if any, frequency of treatment, and the nature of the effect desired. The ranges of effective doses provided below are not intended to limit the inventors and represent preferred dose ranges. However, the most preferred dosage will be tailored to the individual subject, as is understood and determinable by one of skill in the art, without undue experimentation.

The total dose required for each treatment may be administered by multiple doses or in a single dose. A PP peptide or functional a chemical derivative thereof may be administered alone or in conjunction with other therapeutics directed to schizophrenia related disorders or other symptoms of the disorder.

Effective amounts of the PP peptide or composition, or a PP anti-idiotypic antibody, are from about 0.01 μg to about 100 mg/kg body weight, and preferably from about 10 μg to about 50 mg/kg body weight, such 0.05, 0.07, 0.09, 0.1, 0.5, 0.7, 0.9, 1, 2, 5, 10, 20, 25, 30, 40, 45, 50, 60, 70, 80, 90 or 100 mg/kg, or any value or range therein.

Preparations for parenteral administration include sterile aqueous or non-aqueous solutions, suspensions, and emulsions, which may contain auxiliary agents or excipients which are known in the art. Pharmaceutical compositions such as tablets and capsules can also be prepared according to routine methods.

Pharmaceutical compositions comprising at least one PP peptide of the present invention may include all compositions wherein the PP peptide is contained in an amount effective to achieve its intended purpose. In addition to the PP peptide, a pharmaceutical composition may contain suitable pharmaceutically acceptable carriers, such as comprising excipients and

auxiliaries which facilitate processing of the active compounds into preparations which can be used pharmaceutically.

Pharmaceutical compositions according to the present invention may further, optionally comprise an antipsychotic, such as an therapeutic agent selected from the group consisting of a phenothiazine derivative, a thioxanthine derivative, a butyrophenone derivative, a dihydroindolone, a dibenzoxazepine derivative and an atypical neuroleptic (see, e.g., Baldessarini, *supra*, Katzung, *supra*).

Pharmaceutical compositions include suitable solutions for administration intravenously, subcutaneously, dermally, orally, mucosally, rectally or may by injection or orally, and contain from about 0.01 to 99 percent, preferably from about 20 to 75 percent of active component (i.e. the antibody) together with the excipient. Pharmaceutical compositions for oral administration include tablets and capsules. Compositions which can be administered rectally include suppositories.

Transgenic Animals. Animal models of psychoses, such as schizophrenia may now be provided according to the present invention by the use of transgenic animals that are inhibited (as psychosis model) or consitutively express (as normal controls) PP peptide related proteins.

The present invention is thus also directed to a transgenic non-human eukaryotic animal (preferably a rodent, such as a rat or mouse) whose germ cells and somatic cells contain genomic DNA according to the present invention which codes for antisense or inhibiting expression products which prevent the expression of PP peptide related proteins having a psychotic protecting effect in normal mammals. Such inhibiting nucleic acids may be introduced into the animal, or an ancestor of the animal, at an embryonic stage, preferably the one-cell, or fertilized oocyte, stage, and generally not later than about the 8-cell stage. The activated sequence, as the term is used herein, means a gene which, when incorporated into the genome of the animal, is expressed in the animal and increases the probability of the development of a psychosis or related disorder in the animal.

There are several means by which such a inhibiting nucleic acid can be introduced into the genome of the animal embryo so as to be chromosomally incorporated and expressed. One method is to transfect the embryo with the gene as it occurs naturally, and select transgenic animals in which the gene has integrated into the chromosome at a locus which results in expression. Other methods for ensuring expression involve modifying the gene or its control sequences prior to introduction into the embryo. One such method is to transfect the embryo with a vector (see above) containing an already modified gene. Other methods are to use a gene the transcription of which is under the control of a inducible or constitutively acting promoter, whether synthetic or of eukaryotic or viral origin, or to use a gene activated by one or more base pair substitutions, deletions, or additions (see above).

Introduction of the desired gene sequence at the fertilized oocyte stage ensures that the transgene is present in all of the germ cells and somatic cells of the transgenic animal and has the potential to be expressed in all such cells. The presence of the transgene in the germ cells of the transgenic "founder" animal in turn means that all its progeny will carry the transgene in all of their germ cells and somatic cells. Introduction of the transgene at a later embryonic stage in a founder animal may result in limited presence of the transgene in some somatic cell lineages of the founder; however, all the progeny of this founder animal that inherit the transgene conventionally, from the founder's germ cells, will carry the transgene in all of their germ cells and somatic cells.

Chimeric non-human mammals in which fewer than all of the somatic and germ cells contain the desired PP peptide related protein inhibiting nucleic acid, produced, for example, when fewer than all of the cells of the morula are transfected in the process of producing the transgenic mammal, are also intended to be within the scope of the present invention.

The techniques described in Leder, U.S. Patent 4,736,866, for producing transgenic non-human mammals may be

used for the production of the transgenic non-human mammal of the present invention. The various techniques described in Palmiter et al., *Ann. Rev. Genet.*, 20, 465-99 (1986), the entire contents of which are hereby incorporated by reference, may also be used.

The animals carrying this gene can be used to test compounds which may affect the progress of psychotic disorders or to test compounds which may be used to prevent the development of psychoses in susceptible patients. These tests can be extremely sensitive because of the propensity of these transgenic animals to develop psychotic disorders. Such animals will also serve as an animal model enabling testing of treatment and diagnostic methods for all psychotic disorders to be performed on non-humans. Transgenic animals according to the present invention can also be used as a source of cells for cell culture.

Muteins of PP peptides of the present invention may include peptides which are distinct from PP peptides according to Figure 1 (SEQ ID NOS: 1-4) in critical structural features, but which maintain anti-schizophrenia biological activity. Such consensus peptides may be derived by molecular modeling, optionally combined with hydrophobicity analysis and/or fitting to model helices, as non-limiting examples. Such modeling can be accomplished according to known method steps using known modeling algorithms, such as, but not limited to, ECEPP, INSIGHT, DISCOVER, CHEM-DRAW, AMBER, FRODO and CHEM-X.

Such consensus peptides or fragments of PPs may then be synthesized or produced recombinantly, in order to provide PP peptides according to the present invention which have anti-schizophrenia or inhibit the biological activity.

In addition, any amide linkage in any of the PP peptides can be replaced by a ketomethylene moiety, e.g. (-C(=O)-CH_2-) for (-(C=O)-NH-). Such derivatives are expected to have the property of increased stability to degradation by enzymes, and therefore possess advantages for the formulation of compounds which may have increased *in vivo* half lives, as

administered by oral, intravenous, intramuscular, intraperitoneal, topical, rectal, intraocular, or other routes.

In addition, any amino acid representing a component of the said peptides can be replaced by the same amino acid but of the opposite chirality. Thus, any amino acid naturally occurring in the L-configuration (which may also be referred to as the R or S, depending upon the structure of the chemical entity) may be replaced with an amino acid of the same chemical structural type, but of the opposite chirality, generally referred to as the D- amino acid but which can additionally be referred to as the R- or the S-, depending upon its composition and chemical configuration. Such derivatives have the property of greatly increased stability to degradation by enzymes, and therefore are advantageous in the formulation of compounds which may have longer *in vivo* half lives, when administered by oral, intravenous, intramuscular, intraperitoneal, topical, rectal, intraocular, or other routes.

Additional amino acid modifications of amino acids of PP peptides of to the present invention may include the following: Cysteinyl residues may be reacted with alpha-haloacetates (and corresponding amines), such as 2-chloroacetic acid or chloroacetamide, to give carboxymethyl or carboxyamidomethyl derivatives. Cysteinyl residues may also be derivatized by reaction with compounds such as bromotrifluoroacetone, alpha-bromo- beta-(5-imidozoyl)propionic acid, chloroacetyl phosphate, N-alkylmaleimides, 3-nitro-2-pyridyl disulfide, methyl 2-pyridyl disulfide, p-chloromercuribenzoate, 2-chloromercuri-4-nitrophenol, or chloro-7-nitrobenzo-2-oxa-1,3-diazole.

Histidyl residues may be derivatized by reaction with compounds such as diethylprocarbonate e.g., at pH 5.5-7.0 because this agent is relatively specific for the histidyl side chain, and para-bromophenacyl bromide may also be used; e.g., where the reaction is preferably performed in 0.1 M sodium cacodylate at pH 6.0.

Lysinyl and amino terminal residues may be reacted with compounds such as succinic or other carboxylic acid

anhydrides. Derivatization with these agents is expected to have the effect of reversing the charge of the lysinyl residues. Other suitable reagents for derivatizing alpha-amino-containing residues include compounds such as imidoesters/e.g., as methyl picolinimidate; pyridoxal phosphate; pyridoxal; chloroborohydride; trinitrobenzenesulfonic acid; O-methylisourea; 2,4 pentanedione; and transaminase-catalyzed reaction with glyoxylate.

Arginyl residues may be modified by reaction with one or several conventional reagents, among them phenylglyoxal, 2,3-butanedione, 1,2-cyclohexanedione, and ninhydrin according to known method steps. Derivatization of arginine residues requires that the reaction be performed in alkaline conditions because of the high pKa of the guanidine functional group. Furthermore, these reagents may react with the groups of lysine as well as the arginine epsilon-amino group.

The specific modification of tyrosyl residues *per se* is well-known, such as for introducing spectral labels into tyrosyl residues by reaction with aromatic diazonium compounds or tetranitromethane. N-acetylimidizol and tetranitromethane may be used to form O-acetyl tyrosyl species and 3-nitro derivatives, respectively.

Carboxyl side groups (aspartyl or glutamyl) may be selectively modified by reaction with carbodiimides (R'-N-C-N-R') such as 1-cyclohexyl-3-(2-morpholinyl- (4-ethyl) carbodiimide or 1- ethyl-3-(4-azonia-4,4- dimethylpentyl) carbodiimide. Furthermore, aspartyl and glutamyl residues may be converted to asparaginyl and glutaminyl residues by reaction with ammonium ions.

Glutaminyl and asparaginyl residues may be frequently deamidated to the corresponding glutamyl and aspartyl residues. Alternatively, these residues may be deamidated under mildly acidic conditions. Either form of these residues falls within the scope of the present invention.

Derivatization with bifunctional agents is useful for cross-linking the peptide to a water-insoluble support matrix or to other macromolecular carriers, according to known method

steps. Commonly used cross-linking agents include, e.g., 1,1-bis(diazoacetyl)-2-phenylethane, glutaraldehyde, N-hydroxysuccinimide esters, for example, esters with 4-azidosalicylic acid, homobifunctional imidoesters, including disuccinimidyl esters such as 3,3'-dithiobis(succinimidylpropionate), and bifunctional maleimides such as bis-N-maleimido-1,8-octane. Derivatizing agents such as methyl-3-[(p-azidophenyl)dithio]propioimidate yield photoactivatable intermediates that are capable of forming crosslinks in the presence of light. Alternatively, reactive water-insoluble matrices such as cyanogen bromide-activated carbohydrates and the reactive substrates described in U.S. Patent Nos. 3,969,287; 3,691,016; 4,195,128; 4,247,642; 4,229,537; and 4,330,440 (which are herein incorporated entirely by reference), may be employed for protein immobilization.

Other modifications of PP peptides of the present invention may include hydroxylation of proline and lysine, phosphorylation of hydroxyl groups of seryl or threonyl residues, methylation of the alpha-amino groups of lysine, arginine, and histidine side chains (T.E. Creighton, *Proteins: Structure and Molecule Properties*, W.H. Freeman & Co., San Francisco, pp. 79-86 (1983)), acetylation of the N-terminal amine, methylation of main chain amide residues (or substitution with N-methyl amino acids) and, in some instances, amidation of the C-terminal carboxyl groups, according to known method steps.

Such derivatized moieties may improve the solubility, absorption, permeability across the blood brain barrier biological half life, and the like. Such moieties or modifications of PP peptides may alternatively eliminate or attenuate any possible undesirable side effect of the protein and the like. Moieties capable of mediating such effects are disclosed, for example, in *Remington's Pharmaceutical Sciences*, 16th ed., Mack Publishing Co., Easton, PA (1980).

Such chemical derivatives of PP peptides also may provide attachment to solid supports, including but not limited to, agarose, cellulose, hollow fibers, or other polymeric carbohydrates such as agarose, cellulose, such as for

purification, generation of antibodies or cloning; or to provide altered physical properties, such as resistance to enzymatic degradation or increased binding affinity or modulation for PP peptides, which is desired for therapeutic compositions comprising PP peptides, antibodies thereto or fragments thereof. Such peptide derivatives are well-known in the art, as well as method steps for making such derivatives using carbodiimides active esters of N-hydroxy succinimide, or mixed anhydrides, as non-limiting examples.

Variation upon consensus peptide sequences of PP peptide of the present invention may also include: the addition of one, two, three, four, or five lysine, arginine or other basic residues added to the -COOH terminal end of the peptide; and/or one, two, three, four, or five glutamate or aspartate or other acidic residues added to the amino terminal end of the peptide, where "acidic" and "basic" are as defined herein. Such modifications are well known to increase the α-helical content of the peptide by the "helix dipole effect". They also can provide enhanced aqueous solubility of the peptide. See, e.g., Baldwin et al., *supra*.

PP peptides of the present invention also include peptides having un-natural amino acids by exploiting a phenomenon known as suppression. Some bacteria, when encountering a nonsense mutation (e.g., an internal stop codon: UAA, UAG, UGA) substitutes an amino acid using a charged transfer RNA that carries the proper anticodon to allow for translocation in spite of the error in RNA sequence (i.e. suppression). By charging the suppressor to RNA with an un-natural amino acid, peptides can be generated with specific substitutions through modification during translation.

Having now generally described the invention, the same will be more readily understood through reference to the following example which is provided by way of illustration, and is not intended to be limiting of the present invention.

Example 1: Isolation of a PP Peptide Encoding Gene from Monozygotic Twins Discordant for Schizophrenia

Monozygotic twins discordant for schizophrenia represent excellent subjects to assay for differences in gene expression at the transcriptional level. The assumption is that variance in phenotype (in this case mental function) is attributable to the way in which the genetic potential is expressed. Removal of commonly expressed transcripts by subtractive hybridization should result in enrichment of phenotype specific gene products even when these transcripts are at less than 0.05% of the total in mRNA population (Travis et al, 1987).

The logical tissue source for these studies is the brain; however, because of our interest in living subjects, an alternative tissue, the peripheral blood lymphocyte was used. While seeming counter-intuitive, it is possible to show that gene expression in an accessible tissue in which a gene has no function may serve to monitor expression in an inaccessible tissue in which the function of the gene product has physiological significance (Chelly et al 1988). Accordingly, we have demonstrated that a subtracted clone obtained from the lymphocytes of a discordant schizophrenic twin pair is expressed in the CNS of rats.

Materials and Methods

The subjects for this study were 64 year old female monozygotic twins discordant for schizophrenia (DSMIIIR). The schizophrenic co-twin had been neuroleptic free for more than 30 years. Lymphocytes from 250 cc of whole blood were isolated by separation on Ficoll-Paque according to the manufacturers' instructions. RNA isolation, cDNA synthesis and cDNA cloning were accomplished as described by Belyavsky et al., *Nucl. Acids Res.* 17:2919-2932 (1989), with minor modifications. A cDNA library was made for each twin and subtractive hybridization was achieved as described in the manual provided in the Subtractor II Kit manufactured by InVitrogen. Libraries were screened with (32p) labeled cDNA using the +/- method for differential clone identification and subsequent isolation. Probes for *in situ*

hybridization were synthesized by *in vitro* transcription with T7 (anti-sense) and SP6 RNA (sense) polymerases in the presence of (33p) labeled UTP, using the subtracted clone as the template. The use of the (33p) labeled results in greater resolution and shorter exposure time as compared to (35s) labeled isotopes.

RESULTS

A flow chart of the procedures used to detect the subtracted clones is shown in Figure 4. Because we did not know, *a priori*, in which subject we would observe differential expression, both libraries had to be used as driver and substrate in two separate subtraction assays.

The number of subtracted clones identified in the assay where the "well" twin's cDNA was used in excess was within the 2% background value determined previously. However, when the cDNA of the "sick" twin was used in excess, the number of differential clones was approximately 4%. We isolated 41 clones for further analysis based on the results of the primary screening. Secondary screening of the clones reduced the number to 20. These twenty clones were then used for mini plasmid preparations and subsequently sequenced. After sequencing the number of clones was reduced to 10.

In order to verify that subtracted clones were differentially expressed we employed an RNase protection assay (RPA). RPA results demonstrated that out of the two clones tested thus far, one clone (pOKSC4c) was differentially expressed. The expression of the clone was greatest for the "well" twin.

The fact that this clone was expressed in the well twin but not the sick is consistent with our conclusion that his gene serves a protective function in the well twin. If as shown earlier schizophrenia is a genetic disorder, both monozygotic twins carry the schizophrenia gene. The well twin expresses pOKSC4c while the schizophrenic twin does not; therefore pOKSC4c must be protecting the well twin from the deleterious effects of the schizophrenia gene.

In this case pOKSC4c is protecting against schizophrenia. In other patients genetically vulnerable to

psychoses other than schizophrenia or vulnerable to other causes of psychosis, pOKSC4c could be expressed to protect against these psychoses. Thus, although pOKSC4c was isolated from twins discordant for schizophrenia, this in no way limits the protective effect of PP peptide to schizophrenia.

In situ hybridization studies were carried out to determine if pOSKC4c was expressed in rat brain. Examination of the *in situ* audioradiograph (Figure 5A) reveals that the two most intense regions of hybridization are: 1) the cortex and 2) the medial geniculate nucleus. CAI to CA3 of Ammon's horn (hippocampus) also hybridize to the clone. The hybridization signal in the cortex seems to be qualitatively higher in certain cortical regions. As seen in Figure 5A, the interhinal cortex, perirhinal cortex and temporal cortex (areas 1 and 3) give a more intense signal than the rest of the cortex. Lastly, these details were completely absent when the sense strand was used as a control (Figure 5B).

DISCUSSION

Chelly et al., *supra* (1988), using quantitative PCR, found that dystrophin message could be detected in lymphocytes from normal subjects but not in lymphocytes of subjects with Duchenne's muscular dystrophy. For the dystrophin gene, at least, a very low level of expression of the gene occurs in lymphocytes even though the gene product, dystrophin, has a function in muscle but not in blood cells. Thus the dystrophin gene appears to "dribble" a very low level of RNA in the lymphocyte, whereas the mutant gene does not "dribble" in lymphocytes of the DMD subjects.

As described above, the probe derived from lymphocytes via subtractive hybridization produces a strong signal in rat cortex and geniculate body. The selective nature of the hybridization in rat brain supports the idea that this gene may be associated with specific functions in the brain rather than be ubiquitously active.

Subtracted cDNA Clones from a Monozygotic Twin Pair Discordant for Schizophrenia pOKSC4c

pOKSC4c: The plasmid contains a 423 bp fragment, encoding what seems to be the 3' end of a previously unreported gene, which has been inserted into the BamH I site of the Invitrogen plasmid pcDNA II. The orientation of the insert is such that the SP6 promoter lies at the 5' end of the gene fragment.

This plasmid was isolated by screening a subtracted cDNA library generated from the RNA of lymphocytes obtained from a set of monozygotic twins discordant for schizophrenia. The cDNA libraries used as substrate for the subtraction assay were constructed using PCR according to the method described by Belyavsky, et al., *Nucl. Acids Res.* 17:2919-2932 (1989), with slight modifications. The two oligonucleotides used in library construction are described below.

Oligonucleotide used for first strand cDNA synthesis and downstream primer during amplification:

3' end of 4c

T7 promoter *ATCGGGCCCCTTTTTTTTTTTTTTTTAAAGA (SEQ ID NO: 5)

Oligonucleotide used for upstream primer during amplification:

5' end of 4c

SP6 promoter *ATCGAAATTCCCCCCCCCCCCCCAGCA (SEQ ID NO: 6)

*Bold characters correspond to partial BamH I restriction endonuclease recognition sites used for insertion.

Preliminary evidence using RNase protection assays provides the clear expectation that the gene corresponding to the pOKSC4c insert is differentially expressed in this set of twins, such that the "well" PP peptide related protein gene makes significantly more of PP peptide related protein than the "sick" co-twin.

Addititionally, data has been obtained which demonstrates that this gene fragment is expressed in rat brain. Characterization of the full length gene accordingly may be provided based on the use of probes based on or derived from SEQ ID NO:1 according to known method steps, without undue

experimentation (see, e.g., Sambrook, *supra*, Ausubel, *supra*). It is also expected that this gene may be used according to the present invention to provide a marker for various psychosis, such as schizophrenia, as well as a means to treat such disorders.

EXAMPLE II: Cloning and expression of PP peptide related proteins.

According to the present invention, 15-45 base portions of SEQ ID NO:1, as present in Figure 1, are used as oligo probes to screen genomic and cDNA libraries according to known method steps as presented in Ausubel, *supra*, and Sambrook, *supra*. Isolated clones are then expressed in suitable expression vectors in appropriate host cells and sequenced as both the DNA encoding the gene and the expressed PP peptide related protein. The protein is then purified and sequenced, and then used to generate antibodies, to generate transgenics expressing and not expressing the PP peptide or related protein, as animal models of psychoses, and as part of therapeutic compositions used for treating various psychotic disorders, such as schizophrenia, as described herein.

EXAMPLE III

Subtracted clones containing DNA encoding PP peptide related protein

According to the methods presented in Examples I and II above, and according to method steps known in the art, the following clones were isolated and sequenced:

pOKSC4c (367 bp*)

The closest homology; Varicella-Zoster virus, as 80.0% identity in 26 bp overlap.

This cDNA seems to be expressed in the "well" twin more abundantly than in the "sick" co-twin as determined by RPA.

This cDNA has also been shown to be expressed in rodent brain in the following areas: cortex (RPA, Northern blot and In situ Hybridization), hippocampus (RPA and In situ hybridization) and medial geniculate nucleus (In situ hybridization).

ATCGGGCCCC TTTTTTTTTT TTTTTTTTTT AGAAATTTAA AATTTAGTGA ACCCAAATAA 60
ATTATTGCGA AACCCAAGGC CACGTAATCA TATGGCAACA GCTATGGCAA CAGCTAATGG 120
TTCGTCTCTA AATCCAGGCC ATCTCTAGTG ATAAGGTCCT AACAGCAAAG CCACTAGGTC 180

CGGACCAGGA AGACAGTGCT ACTCACCTAC TGGCGGTCTG GCACTATCTG TAGGCTGGAG 240
TTGGGCTGGG GATGGTACAT TCAAAATGGA CTTTGGTAAA CTAGGGACAA CACTGCAGAA 300
AGGAGGAAGG ACTCCCTTTC CAGCATCTCA AATTCAAGGC TCCAAGTTAC TGGGCTTGGG 360
CAAAGTCACA CATTTTCTCA ACAAAGGCCA ACTGCTGAAA AGGGGGGGGG GGGGAATTTC 420
GAT 423 (SEQ ID NO: 8)

pOKSC25b (206 bp)

The closest homology is to Human alpha satellite DNA from clone pTRA-4, with a 76.9% identity in 26 pb overlap seems to be expressed in the "well" twin more abundantly than in the "sick" co-tein as determined by RPA.

TTTTTTTTTT TTTTTGGTTC ATCTATATTT TCTCATTTAC CTCTAATATG AAACACTTGT 60
GTATCAAAAG AAAAGCATAT ACTTTTAAAA CAAATTATTT TCAATTACTA TTGTTTTGGG 120
TTATCAATAC CACTGTTTAT TGCCCTGGGT GAATCGAGGC CATTTTGCAA CATACATCCA 180
GCCAGGCTGA AAACACTTAC TTTATTCCGA GTCCATACGA AGGGGGGGGG GGGGAATTTC 240
GAT 243
(SEQ ID NO:9)

pOKSC20a (356 bp)

The closest homology: Human dystrophin gene, with a 74.1% identity in 27 bp overlap.

ATCGAAATTC CCCCCCCCCC CCTTTGGAAG ATTTATTAAT TGATTAAGGA CTAGGAGGTC 60
CAGCTAAAAT GCAATTGGAT TTATTAAGGT ACTTAAATCC AGATTTAAGG TATGAAATCA 120
AGAATGGCGA ACAAAAAAAA AAAAAAAAGG GGCCCGAT 158 (SEQ ID NO:10)

pOKSC20a (356 bp)

The closest homology is to Human Hypoxanthine phosphoribosyltransferase (HPRT) gene, with a 63.3% identity in a 49 bp overlap. Seems to be expressed in the "well" twin more abundantly than in the "sick" co-twin as determined by RPA. Preliminary analysis suggests that it is also expressed in rat brain (Northern blot).

ATCGGGCCCC TTTTTTTTTT TTTTTTGTGG ATTAGATTTT AATGTGAATT TTGGAAGTAC 60
ACAAAATGTT CAAACTATAG CATGATATAT ATCAAGTTGG CAGTATAAAC TACTTTCAAG 120
TAACTTTAGA ACACAAGTGT TTGCCCATTC CTAGTGAGAT GGATTCTAAT TGAGATATTA 180
GCTAGCTGAA CATTCCAGTT GGTAAGTTGT CTACATATTT AAGATATGTA ACCAACCAAC 240
CAACTAGTAG TGATACCTCA CATCATCACT GAGTTGACTT CGTACAGCGC AGTTCATGAT 300

AGCATGTGAC AGCTCTAATA AATCACACAG TTGGTATAGA AAACCAACTG GCTGTTCGTC 360
TGTTTGGCCC AAAACTGTTC TTGGAGGGGG GGGGGGGGAA TTTCGTA 407 (SEQ ID NO:11)

pOKCS12b (201 bp)

This clone has some identity with Human complete G6PD gene for glucose 6 phosphate dehydrogenase, with a 83.7% in 172 bp overlap.

ATCGGGCCCC TTTTTTTTTT TTTTTTAGAT CTTTAAATGT GCTTTATCAG GCCAGGCACA 60
GTGGCTCAGG CCTGTAATCC TAGCACTTTT CGGAGGCGGA GGTAGGTGGA TCACTTGAGG 120
TCAGGAGTTC AAGAGCAGCC TGGCCAACAT GGTGAACCCT GTCTCTACTG AAAATACAAA 180
ACTTAGCCAT TGGTGGTGGT GCATGCCTGT AGGCCCAGCT AACTAAAGGG GGGGGGGGGG 240
AATTTCGAT 249 (SEQ ID NO:12)

pOKSC18a (45 bp)

ATCGCCCCTT TTTTTTTTTT TTTTTTTTGA GATGGAGTTT CTCTCTTGTT GCCCAGGCTG 60
GATGGAGTGC AATGGGGGGG GGGGGGAATT TCGAT 95 (SEQ ID NO:13)

pOKSC37a (174 bp)

This clone has some identity with human heparin cofactor II (HCF2) gene, as exons 1 through 5, having 78.1% identity in a 169 bp overlap.

ATGCAAATTC CCCCCCCCCC CCTGTCTCTA GTAAAAATAC AAAAATTGGC CGAGCGTGAA 60
GGCTGGCGCC TCTAATCCCA GCTTCTTGGG AAGCTGAGGG AAGCTGAGGC ACAAGAATTT 120
GCTTGAGCCC ACGAGTGGTT GAATGCCAGG ACCTGTCCAC TGCACTCCAG CCTGGGCGAC 180
AGAACGACAC TGTCTCAAAA AAAAAAAAAA AAGGGGCCCG AT 222 (SEQ ID NO:14)

pOKSC41a (212 bp)

This clone has identity with human seglycin gene, exons 1, 2 and 3, as a 83% identity in 212 bp overlap.

ATCGAAATTC CCCCCCCCCC CCGTCTGGAG TTCAAAACCA TCCTGGCATT TATGGTGAAA 60
CCCTGTCTCT ACTAAAAATA CAAAATAGAC AGGTGTGGGT GTCACGCCTG TAGTCCCAGC 120
TACTCGGAAG GCTGAGGCAG GAGAATCGCT TGAACCTGGG AGGCAGAGGT TGCATTGAGG 180
CAAGATCGCA CCACTGTACT CCAGCCAGGG TGACAGAGCG GGACTCTGTC ATTTAAAAAA 240
AAAAAAAAAA GGGGCCCGAT 260 (SEQ ID NO:15)

pOKSC6f (247 bp)

This clone has identity with human beta globin region on chromosome 11, as having a 61.3% identity in 173 bp overlap.

ATCGAAATTC CCCCCCCCCC CCATGTTATC CCTTGAATGT AGTGTGTAAC AGAGAGAGAT 60
GTTTCTTTCT TTCTTTGATT ATCTGAGAAG CTAGGCAGGT GAAAGAACTT TCTTGTCCTC 120
CATTCAGAAA TAATTTACAG GCAGTTACTT CTAAATATGC ATGCCTGGGC CAAATGTGGT 180
GGCTCACACC TGTAATCCCA ACCCTGGGAA GCTGAGGCAG GAGGATTGCT TGCAACCAGC 240
CTGGGTAGAC ATAGTGAAAC CTGTCTCTCA AAAAAAAAAA AAAAAGGGGC CCGAT 295
(SEQ ID NO:16)

pOKSC8a (31 bp)

ATCGAAATTC CCCCCCCCCC CCAGCCTGGG CGACAGAGAG CCAAACGCCG TCTGAAAAAA 60
AAAAAAAAAA GGGGCCCGAT 80 (SEQ ID NO:17)

All underlined sequences above represent PCR primers used to generate the cDNA libraries. Sequence analysis was performed using GCG 7 software package. Identity was ascertained if greater than 50% of the cDNA length displayed greater than 50% homology. Also in the above sequences and description, bp = base pairs, RPA = RNase Protection Assay and PCR = Polymerase Chain Reaction.

All references cited herein, including journal articles or abstracts, published or corresponding U.S. or foreign patent applications, issued U.S. or foreign patents, or any other references, are entirely incorporated by reference herein, including all data, tables, figures, and text presented in the cited references. Additionally, the entire contents of the references cited within the references cited herein are also entirely incorporated by reference.

Reference to known method steps, conventional methods steps, known methods or conventional methods is not in any way an admission that any aspect, description or embodiment of the present invention is disclosed, taught or suggested in the relevant art.

The foregoing description of the specific embodiments will so fully reveal the general nature of the invention that

others can, by applying knowledge within the skill of the art (including the contents of the references cited herein), readily modify and/or adapt for various applications such specific embodiments, without undue experimentation, without departing from the general concept of the present invention. Therefore, such adaptations and modifications are intended to be within the meaning and range of equivalents of the disclosed embodiments, based on the teaching and guidance presented herein. It is to be understood that the phraseology or terminology herein is for the purpose of description and not of limitation, such that the terminology or phraseology of the present specification is to be interpreted by the skilled artisan in light of the teachings and guidance presented herein, in combination with the knowledge of one of ordinary skill in the art.

SEQUENCE LISTING

(1) GENERAL INFORMATION:

(i) APPLICANT: FRIEDHOFF, ARNOLD J.
BASHAM, DARYL A.
MILLER, JEANETTE C.

(ii) TITLE OF INVENTION: PSYCHOSIS PROTECTING NUCLEIC ACID, PEPTIDES, COMPOSITIONS AND METHOD OF USE

(iii) NUMBER OF SEQUENCES: 17

(iv) CORRESPONDENCE ADDRESS:
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(C) CITY: WASHINGTON
(D) STATE: D.C.
(E) COUNTRY: USA
(F) ZIP: 20004

(v) COMPUTER READABLE FORM:
(A) MEDIUM TYPE: Floppy disk
(B) COMPUTER: IBM PC compatible
(C) OPERATING SYSTEM: PC-DOS/MS-DOS
(D) SOFTWARE: PatentIn Release #1.0, Version #1.25

(vii) PRIOR APPLICATION DATA:
(A) APPLICATION NUMBER: US 08/060,560
(B) FILING DATE: 13-MAY-1993

(viii) ATTORNEY/AGENT INFORMATION:
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(B) REGISTRATION NUMBER: 34,003
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(C) TELEX: 248633

(2) INFORMATION FOR SEQ ID NO:1:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 423 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(ix) FEATURE:
(A) NAME/KEY: CDS
(B) LOCATION: 1..423
(D) OTHER INFORMATION: /note= "Xaa is unknown"

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:1:

```
TAG CCC GGG GAA AAA AAA AAA AAA AAA AAA TCT TTA AAT TTT AAA TCA        48
Xaa Pro Gly Glu Lys Lys Lys Lys Lys Lys Ser Leu Asn Phe Lys Ser
 1               5                  10                  15

CTT GGG TTT ATT TAA TAA CGC TTT GGG TTC CGG TGC ATT AGT ATA CCG        96
Leu Gly Phe Ile Xaa Xaa Arg Phe Gly Phe Arg Cys Ile Ser Ile Pro
            20                  25                  30

TTG TCG ATA CCG TTG TCG ATT ACC AAG CAG AGA TTT AGG TCC GGT AGA       144
```

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Leu Ser Ile Pro Leu Ser Ile Thr Lys Gln Arg Phe Arg Ser Gly Arg
          35                  40                  45

GAT CAC TAT TCC AGG ATT GTC GTT TCG GTG ATC CAG GCC TGG TCC TTC        192
Asp His Tyr Ser Arg Ile Val Val Ser Val Ile Gln Ala Trp Ser Phe
 50                  55                  60

TGT CAC GAT GAG TGG ATG ACC GCC AGA CCG TGA TAG ACA TCC GAC CTC        240
Cys His Asp Glu Trp Met Thr Ala Arg Pro Xaa Xaa Thr Ser Asp Leu
 65                  70                  75                  80

AAC CCG ACC CCT ACC ATG TAA GTT TTA CCT GAA ACC ATT TGA TCC CTG        288
Asn Pro Thr Pro Thr Met Xaa Val Leu Pro Glu Thr Ile Xaa Ser Leu
                 85                  90                  95

TTG TGA CGT CTT TCC TCC TTC CTG AGG GAA AGG TCG TAG AGT TTA AGT        336
Leu Xaa Arg Leu Ser Ser Phe Leu Arg Glu Arg Ser Xaa Ser Leu Ser
            100                 105                 110

TCC GAG GTT CAA TGA CCC GAA CCC GTT TCA GTG TGT AAA AGA GTT GTT        384
Ser Glu Val Gln Xaa Pro Glu Pro Val Ser Val Cys Lys Arg Val Val
        115                 120                 125

TCC GGT TGA CGA CTT TTC CCC CCC CCC CCC TTA AAG CTA                    423
Ser Gly Xaa Arg Leu Phe Pro Pro Pro Pro Leu Lys Leu
    130                 135                 140
```

(2) INFORMATION FOR SEQ ID NO:2:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 141 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(ix) FEATURE:
(D) OTHER INFORMATION: /note= "Xaa is unknown"

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:2:

```
Xaa Pro Gly Glu Lys Lys Lys Lys Lys Ser Leu Asn Phe Lys Ser
 1               5                  10                  15

Leu Gly Phe Ile Xaa Xaa Arg Phe Gly Phe Arg Cys Ile Ser Ile Pro
            20                  25                  30

Leu Ser Ile Pro Leu Ser Ile Thr Lys Gln Arg Phe Arg Ser Gly Arg
         35                  40                  45

Asp His Tyr Ser Arg Ile Val Val Ser Val Ile Gln Ala Trp Ser Phe
     50                  55                  60

Cys His Asp Glu Trp Met Thr Ala Arg Pro Xaa Xaa Thr Ser Asp Leu
 65                  70                  75                  80

Asn Pro Thr Pro Thr Met Xaa Val Leu Pro Glu Thr Ile Xaa Ser Leu
                 85                  90                  95

Leu Xaa Arg Leu Ser Ser Phe Leu Arg Glu Arg Ser Xaa Ser Leu Ser
            100                 105                 110

Ser Glu Val Gln Xaa Pro Glu Pro Val Ser Val Cys Lys Arg Val Val
        115                 120                 125

Ser Gly Xaa Arg Leu Phe Pro Pro Pro Pro Leu Lys Leu
```

130 135 140

(2) INFORMATION FOR SEQ ID NO:3:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 140 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(ix) FEATURE:
(D) OTHER INFORMATION: /note= "Xaa is unknown"

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:3:

Ser Pro Gly Lys Lys Lys Lys Lys Lys Asn Leu Xaa Ile Leu Asn His
1 5 10 15

Leu Gly Leu Phe Asn Asn Ala Leu Gly Ser Gly Ala Leu Val Tyr Arg
20 25 30

Cys Arg Tyr Arg Cys Arg Leu Pro Ser Arg Asp Leu Gly Pro Val Glu
35 40 45

Ile Thr Ile Pro Gly Leu Ser Phe Arg Xaa Ser Arg Pro Gly Pro Ser
50 55 60

Val Thr Met Ser Gly Xaa Pro Pro Asp Arg Asp Arg His Pro Thr Ser
65 70 75 80

Thr Arg Pro Leu Pro Cys Lys Phe Tyr Leu Lys Pro Phe Asp Pro Cys
85 90 95

Cys Asp Val Phe Pro Pro Ser Xaa Gly Lys Gly Arg Arg Val Xaa Val
100 105 110

Pro Arg Phe Asn Asp Pro Asn Pro Phe Gln Cys Val Lys Glu Leu Phe
115 120 125

Pro Val Asp Asp Phe Ser Pro Pro Pro Pro Xaa Ser
130 135 140

(2) INFORMATION FOR SEQ ID NO:4:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 140 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(ix) FEATURE:
(D) OTHER INFORMATION: /note= "Xaa is unknown"

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:4:

Ala Arg Gly Lys Lys Lys Lys Lys Ile Phe Lys Phe Xaa Ile Thr
1 5 10 15

Trp Val Tyr Leu Ile Thr Leu Trp Val Pro Val His Xaa Tyr Thr Val
20 25 30

Val Asp Thr Val Val Asp Tyr Gln Ala Glu Ile Xaa Val Arg Xaa Arg

35 40 45

Ser Leu Phe Gln Asp Cys Arg Phe Gly Asp Pro Gly Leu Val Leu Leu
50 55 60

Ser Arg Xaa Val Asp Asp Arg Gln Thr Val Ile Asp Ile Arg Pro Gln
65 70 75 80

Pro Asp Pro Tyr His Val Ser Phe Thr Xaa Asn His Leu Ile Pro Val
85 90 95

Val Thr Ser Phe Leu Leu Pro Glu Gly Lys Val Val Glu Phe Lys Phe
100 105 110

Arg Gly Ser Met Thr Arg Thr Arg Phe Ser Val Xaa Lys Ser Cys Phe
115 120 125

Arg Leu Thr Thr Phe Pro Pro Pro Pro Leu Lys Ala
130 135 140

(2) INFORMATION FOR SEQ ID NO:5:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 31 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:5:

ATCGGGCCCC TTTTTTTTTT TTTTTTAAAG A 31

(2) INFORMATION FOR SEQ ID NO:6:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 27 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:6:

ATCGAAATTC CCCCCCCCCC CCCAGCA 27

(2) INFORMATION FOR SEQ ID NO:7:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 12 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:7:

CCANNNNNNT GG 12

(2) INFORMATION FOR SEQ ID NO:8:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 423 base pairs
(B) TYPE: nucleic acid

(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:8:

ATCGGGCCCC TTTTTTTTTT TTTTTTTTTT AGAAATTTAA AATTTAGTGA ACCCAAATAA 60
ATTATTGCGA AACCCAAGGC CACGTAATCA TATGGCAACA GCTATGGCAA CAGCTAATGG 120
TTCGTCTCTA AATCCAGGCC ATCTCTAGTG ATAAGGTCCT AACAGCAAAG CCACTAGGTC 180
CGGACCAGGA AGACAGTGCT ACTCACCTAC TGGCGGTCTG GCACTATCTG TAGGCTGGAG 240
TTGGGCTGGG GATGGTACAT TCAAAATGGA CTTTGGTAAA CTAGGGACAA CACTGCAGAA 300
AGGAGGAAGG ACTCCCTTTC CAGCATCTCA AATTCAAGGC TCCAAGTTAC TGGGCTTGGG 360
CAAAGTCACA CATTTTCTCA ACAAAGGCCA ACTGCTGAAA AGGGGGGGGG GGGGAATTTC 420
GAT 423

(2) INFORMATION FOR SEQ ID NO:9:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 243 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:9:

TTTTTTTTTT TTTTTGGTTC ATCTATATTT TCTCATTTAC CTCTAATATG AAACACTTGT 60
GTATCAAAAG AAAAGCATAT ACTTTTAAAA CAAATTATTT TCAATTACTA TTGTTTTGGG 120
TTATCAATAC CACTGTTTAT TGCCCTGGGT GAATCGAGGC CATTTTGCAA CATACATCCA 180
GCCAGGCTGA AAACACTTAC TTTATTCCGA GTCCATACGA AGGGGGGGGG GGGGAATTTC 240
GAT 243

(2) INFORMATION FOR SEQ ID NO:10:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 158 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:10:

ATCGAAATTC CCCCCCCCCC CCTTTGGAAG ATTTATTAAT TGATTAAGGA CTAGGAGGTC 60
CAGCTAAAAT GCAATTGGAT TTATTAAGGT ACTTAAATCC AGATTTAAGG TATGAAATCA 120
AGAATGGCGA ACAAAAAAAA AAAAAAAAGG GGCCCGAT 158

(2) INFORMATION FOR SEQ ID NO:11:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 407 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:11:

ATCGGGCCCC TTTTTTTTTT TTTTTTGTGG ATTAGATTTT AATGTGAATT TTGGAAGTAC 60

ACAAAATGTT CAAACTATAG CATGATATAT ATCAAGTTGG CAGTATAAAC TACTTTCAAG 120

TAACTTTAGA ACACAAGTGT TTGCCCATTC CTAGTGAGAT GGATTCTAAT TGAGATATTA 180

GCTAGCTGAA CATTCCAGTT GGTAAGTTGT CTACATATTT AAGATATGTA ACCAACCAAC 240

CAACTAGTAG TGATACCTCA CATCATCACT GAGTTGACTT CGTACAGCGC AGTTCATGAT 300

AGCATGTGAC AGCTCTAATA AATCACACAG TTGGTATAGA AAACCAACTG GCTGTTCGTC 360

TGTTTGGCCC AAAACTGTTC TTGGAGGGGG GGGGGGGGAA TTTCGTA 407

(2) INFORMATION FOR SEQ ID NO:12:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 249 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:12:

ATCGGGCCCC TTTTTTTTTT TTTTTTAGAT CTTTAAATGT GCTTTATCAG GCCAGGCACA 60

GTGGCTCAGG CCTGTAATCC TAGCACTTTT CGGAGGCGGA GGTAGGTGGA TCACTTGAGG 120

TCAGGAGTTC AAGAGCAGCC TGGCCAACAT GGTGAACCCT GTCTCTACTG AAAATACAAA 180

ACTTAGCCAT TGGTGGTGGT GCATGCCTGT AGGCCCAGCT AACTAAAGGG GGGGGGGGGG 240

AATTTCGAT 249

(2) INFORMATION FOR SEQ ID NO:13:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 95 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:13:

ATCGCCCCTT TTTTTTTTTT TTTTTTTTGA GATGGAGTTT CTCTCTTGTT GCCCAGGCTG 60

GATGGAGTGC AATGGGGGGG GGGGGGAATT TCGAT 95

(2) INFORMATION FOR SEQ ID NO:14:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 222 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:14:

ATGCAAATTC CCCCCCCCCC CCTGTCTCTA GTAAAAATAC AAAAATTGGC CGAGCGTGAA 60

GGCTGGCGCC TCTAATCCCA GCTTCTTGGG AAGCTGAGGG AAGCTGAGGC ACAAGAATTT 120

GCTTGAGCCC ACGAGTGGTT GAATGCCAGG ACCTGTCCAC TGCACTCCAG CCTGGGCGAC 180

AGAACGACAC TGTCTCAAAA AAAAAAAAAA AAGGGGCCCG AT 222

(2) INFORMATION FOR SEQ ID NO:15:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 260 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:15:

ATCGAAATTC CCCCCCCCCC CCGTCTGGAG TTCAAAACCA TCCTGGCATT TATGGTGAAA 60

CCCTGTCTCT ACTAAAAATA CAAAATAGAC AGGTGTGGGT GTCACGCCTG TAGTCCCAGC 120

TACTCGGAAG GCTGAGGCAG GAGAATCGCT TGAACCTGGG AGGCAGAGGT TGCATTGAGG 180

CAAGATCGCA CCACTGTACT CCAGCCAGGG TGACAGAGCG GGACTCTGTC ATTTAAAAAA 240

AAAAAAAAAA GGGGCCCGAT 260

(2) INFORMATION FOR SEQ ID NO:16:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 295 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:16:

ATCGAAATTC CCCCCCCCCC CCATGTTATC CCTTGAATGT AGTGTGTAAC AGAGAGAGAT 60

GTTTCTTTCT TTCTTTGATT ATCTGAGAAG CTAGGCAGGT GAAAGAACTT TCTTGTCCTC 120

CATTCAGAAA TAATTTACAG GCAGTTACTT CTAAATATGC ATGCCTGGGC CAAATGTGGT 180

GGCTCACACC TGTAATCCCA ACCCTGGGAA GCTGAGGCAG GAGGATTGCT TGCAACCAGC 240

CTGGGTAGAC ATAGTGAAAC CTGTCTCTCA AAAAAAAAAA AAAAAGGGGC CCGAT 295

(2) INFORMATION FOR SEQ ID NO:17:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 80 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:17:

ATCGAAATTC CCCCCCCCCC CCAGCCTGGG CGACAGAGAG CCAAACGCCG TCTGAAAAAA 60

AAAAAAAAAA GGGGCCCGAT 80

WHAT IS CLAIMED IS:

1. An isolated nucleic acid, comprising a nucleotide sequence of 30 nucleotides to a number of nucleotides selected from the group consisting of 80, 95, 158, 222, 243, 249, 260, 295, 407 and 423, said sequence substantially corresponding to SEQ ID NOS:1-17.

2. A method according to claim 1, wherein said nucleotide sequence is 30-100 bases in length.

3. A nucleic acid according to claim 1, wherein said nucleotide sequence further comprises a detectable label as a detectable probe which can be detected *in vivo*, *in situ*, or *in vitro*.

4. A method for probe detection of a psychosis protecting PP nucleic acid sequence encoding a psychosis protecting PP peptide related protein in a sample suspected of having said sequence, comprising

(a) contacting said sample with at least one detectably labeled probe according to claim 3; and

(b) detecting the labeled probe which has hybridized to the PP nucleic acid sequence.

5. A method according to claim 4, wherein said labeled probe is labeled with a label selected from the group consisting of an enzyme label, a radioisotopic label, a chemical label, a fluorescent label, a modified base, a restriction enzyme sensitive label, an allele specific label, a ligase mediated label and a fluorescence energy transfer label.

6. A method according to claim 4, wherein said sample is selected from blood, sera, urine, saliva, stools or CSF.

7. A method according to claim 4, further comprising

(c) isolating said PP nucleic acid sequence encoding a psychosis protecting PP peptide related protein.

8. A psychosis protecting PP nucleic acid, comprising a polynucleotide consisting essentially of a PP nucleic acid provided by a method according to claim 7.

9. A method according to claim 8, for providing said PP peptide related protein, further comprising

(d) providing said PP nucleic acid sequence in an expression vector in a host cell capable of expressing said PP nucleic acid sequence as said PP peptide related protein under conditions that said PP peptide related protein is expressed in recoverable amounts; and

(e) recovering said PP peptide related protein.

10. A psychoses protecting PP peptide related protein, comprising an isolated polypeptide obtained by a method according to claim 9 or encoded by a nucleic acid according to claim 1.

11. A psychosis protecting PP peptide, comprising a 10-141 amino acid, isolated peptide having an amino acid sequence substantially identical to that of a PP peptide related protein according to claim 10.

12. A PP peptide according to claim 11, wherein said PP peptide has anti-psychosis biological activity.

13. A method for amplifying a psychosis protecting PP nucleic acid sequence encoding a psychosis protecting PP peptide related protein in a sample suspected of having said sequence, comprising

(a) amplifying said PP nucleic acid sequence using nucleotide primers comprising oligonucleotides corresponding or complimentary to a nucleic acid according to claim 1 of 10-150 bases to provide an amplified nucleic acid.

14. A method according to claim 13, wherein said amplifying is selected from polymerase chain reaction or RNA mediated amplification.

15. A method according to claim 13, wherein said specific nucleotide sequence is DNA or RNA.

16. An isolated psychosis protecting PP peptide, comprising a 10-141 amino acid fragment or mutein of a PP peptide related protein expressed in a human in sufficient amounts to substantially reduce or prevent at least one symptom associated with a psychotic disorder, wherein said protein is not substantially expressed in a human having a symptom associated with schizophrenia or other psychoses.

17. A psychosis associated protein according to claim 16, wherein said protein is at least 80% homologous to at least one of SEQ ID NO:2, SEQ ID NO:3 or SEQ ID NO:4.

18. A psychosis associated protein according to claim 16, wherein said protein is at least 80% homologous to a protein encoded by a nucleic acid comprising at least one coding region of SEQ ID NOS:8-17.

19. A composition comprising a PP peptide according to claim 11, or a pharmaceutically acceptable ester, ether, sulfate, carbonate, glucuronide or salt thereof, and a pharmaceutically acceptable carrier.

20. A method for treating a subject suffering from a psychotic disorder, comprising

(a) administering to said subject a therapeutically effective amount of a PP peptide according to claim 11 in a pharmaceutically acceptable form.

21. The method of claim 20, wherein said PP peptide is administered to provide said PP peptide in an amount ranging from about 0.01 μg to 100 mg/kg per day.

22. A method for producing a PP peptide, wherein said PP peptide is a recombinant PP peptide obtained from a recombinant host which expresses a heterologous nucleic acid encoding said PP peptide, comprising the steps of:

(A) providing a host comprising a recombinant nucleic acid encoding a PP peptide according to claim 11 in expressible form;

(B) culturing said host under conditions such that said PP peptide is expressed in recoverable amounts; and

(C) recovering said PP peptide produced by said host.

23. The method of claim 22, further comprising:

(D) purifying said PP peptide.

24. The method of claim 22, wherein said host is a bacteria or a eukaryotic cell.

25. The method of claim 22, wherein said eukaryotic cell is a mammalian cell, an insect cell or a yeast cell.

26. A method for producing a PP peptide according to claim 11, comprising:

(a) chemically synthesizing a PP peptide according to claim 3 in recoverable amounts; and

(b) purifying said PP peptide.

27. An anti-psychosis protecting PP peptide antibody, or fragment thereof, comprising an antibody or fragment that specifically binds an epitope of a PP peptide according to claim 11.

28. An anti-PP peptide antibody or fragment of claim 27, wherein said anti-PP peptide antibody or fragment is detectably labeled with a label to provide a labeled antibody or fragment which can be detected *in vivo*, *in situ*, or *in vitro*.

29. A method for detecting a PP peptide or related protein in a sample, comprising:

(a) contacting said sample with a labeled anti-PP peptide antibody or fragment according to claim 28, such that said labeled anti-PP antibody or fragment associates with said PP peptide or related protein; and

(b) detecting said labeled PP peptide or related protein in said sample which is bound to said labeled antibody.

30. A vector comprising a nucleic acid according to claim 1.

31. A host cell comprising the nucleic acid of claim 1.

32. A nucleic acid encoding a PP peptide related protein according to claim 11.

33. A transgenic non-human mammal essentially all of whose germ cells and somatic cells contain a recombinant activate gene sequence capable of inhibiting expression of a psychotic protecting peptide PP related protein according to claim 11.

34. A transgenic mammal according to claim 33, wherein said gene sequence is an antisense sequence complementary to a nucleic acid according to claim 31.

35. A transgenic mammal according to claim 34, wherein said antisense sequence is complementary to at least 10 bases of one selected from SEQ ID NOS:1-17.

36. A chimeric non-human mammal at least some of whose cells contain a recombinant activated gene sequence encoding an inhibiting expression of a psychotic protecting PP peptide related protein according to claim 11.

37. A transgenic mammal according to claim 36, wherein said gene sequence is an antisense sequence corresponding to a PP peptide related protein encoding nucleic acid according to claim 31.

38. A transgenic mammal according to claim 37, wherein said antisense sequence is complementary to at least 10 bases of Figure 1 (SEQ ID NO:1).

FIG. 1A

Three phase Translation

1/1 31/11

*TAG CTT TAA GGG GGG GGG GGG GAA AAG TCG TCA ACC GGA AAC AAC TCT TTT ACA CAC TGA

AMB leu **OCH** gly gly gly gly glu lys ser ser thr gly asn asn ser phe thr his **OPA**

ser phe lys gly gly gly gly lys ser arg gln pro glu thr thr leu leu his thr glu

ala leu arg gly gly gly gly lys val val asn arg lys gln leu phe tyr thr leu lys

61/21 91/31

AAC GGG TTC GGG TCA TTG AAC CTC GGA ACT TAA ACT CTA CGA CCT TTC CCT CAG GAA GGA

asn gly phe gly ser leu asn leu gly thr **OCH** thr leu arg pro phe pro gln glu gly

thr gly ser gly his **OPA** thr ser glu leu lys leu tyr asp leu ser leu arg lys glu

arg val arg val ile glu pro arg asn leu asn ser thr thr phe pro ser gly arg arg

121/41 151/51

GGA AAG ACG TCA CAA CAG GGA TCA AAT GGT TTC AGG TAA AAC TTA CAT GGT AGG GGT CGG

gly lys thr ser gln gln gly ser asn gly phe arg **OCH** asn leu his gly arg gly arg

glu arg arg his asn arg asp gln met val ser gly lys thr tyr met val gly val gly

lys asp val thr thr gly ile lys trp phe gln val lys leu thr trp **AMB** gly ser gly

181/61 211/71

GTT GAG GTC GGA TGT CTA TCA CGG TCT GGC GGT CAT CCA CTC ATC GTG ACA GAA GGA CCA

val glu val gly cys leu ser arg ser gly gly his pro leu ile val thr glu gly pro

leu arg ser asp val tyr his gly leu ala val ile his ser ser **OPA** gln lys asp gln

OPA gly arg met ser ile thr val trp arg ser ser thr his arg asp arg arg thr arg

*Underlined sequences correspond to oligonucleotide primers

FIG. 1B

Three Phase Translation

241/81 271/91

GGC CTG GAT CAC CGA AAC GAC AAT CCT GGA ATA GTG ATC TCT ACC GGA CCT AAA TCT CTG

gly leu asp his arg asn asp asn pro gly ile val ile ser thr gly pro lys ser leu

ala trp ile thr glu thr thr ile leu glu **AMB** **OPA** ser leu pro asp leu asn leu cys

pro gly ser pro lys arg gln ser trp asn ser asp leu tyr arg thr **OCH** ile ser ala

301/101 331/111

CTT GGT AAT CGA CAA CGG TAT CGA CAA CGG TAT ACT AAT GCA CCG GAA CCC AAA GCG TTA

leu gly asn arg gln arg tyr arg gln arg tyr thr asn ala pro glu pro lys ala leu

leu val ile asp asn gly ile asp asn gly ile leu met his arg asn pro lys arg tyr

trp **OCH** ser thr thr val ser thr thr val tyr **OCH** cys thr gly thr gln ser val ile

361/121 391/131

TTA AAT AAA CCC AAG TGA TTT AAA ATT TAA AGA *<u>TTT TTT TTT TTT TTT TTT TTC CCC GGG</u>

leu asn lys pro lys **OPA** phe lys ile **OCH** arg phe phe phe phe phe phe phe pro gly

OCH ile asn pro ser asp leu lys phe lys asp phe phe phe phe phe phe ser pro gly

lys **OCH** thr gln val ile **OCH** asn leu lys ile phe phe phe phe phe phe pro arg ala

421/141

<u>CTA</u>

leu

*Underlined sequences correspond to oligonucleotide primers.

FIG. 2A (1)

Positions of Restriction Endonucleases sites


```
    Sau96 I
    Nla IV
    Hae III
  Sau96 I
  Nla IV
  Eco0109 I
  Bsp1286 I
  Ban II                Mse I
  Apa I                 Dra I
  ||                    ||
ATCGGGCCCC TTT TTTT TTT TTT TTTT TTTAGAAAT TTAAAATTTAGTGAACCCAAATAA      60
  TAGCCCGGGGAAAAAAAAAAAAAAAAAAATC TTTAAA TTTTAAATCACTTGGGT TTATT
  ||   .    .    .  ||  .   .    .
  4                   36
  4                   37
  4
  4
  4
  4
   5
   5
   5
```

FIG. 2A (2)

Positions of Restriction Endonucleases sites

```
          Hae III
          Hae I
      Sty I  Mae II
      Sec I BsaA I  Nde I   Alu I     Alu I
      |  ||||   |       |      |
ATTATTGCGAAACCCAAGGCCACGTAATCATATGGCAACAGCTATGGCAACAGCTAATGG    120
TAATAACGCTTTGGGT TCCGGTGCATTAGTATACCGT TGTCGATACCGTTGTCGAT TACC
    .  | || .||    |.      |       . |   .
      74   81    89      100      112
      74    82
       77
       78
                                 Msp I
        Hae III                   Hpa II
        Hae I        Sau96 I        BspM II
       ScrF I        Ava II        Sau96 I
       EcoR II       PpuM I          Ava II
 BsmA I  BstN I    Mae I  Eco0109 I      Mae I
|    | ||    |    ||           |||
TTCGTCTCTAAATCCAGGCCATCTCTAGTGATAAGGTCCTAACAGCAAAGCCACTAGGTC    180
AAGCAGAGATTTAGGTCCGGTAGAGATCACTATTCCAGGATTGTCGTTTCGGTGATCCAG
 |  .  | ||.  | .  ||   .     .  || ||
 124   134    145    154         174
       134          154          177
       134          155          177
        136         155           179
        137                      180/180
```

FIG. 2A (3)

Positions of Restriction Endonucleases sites

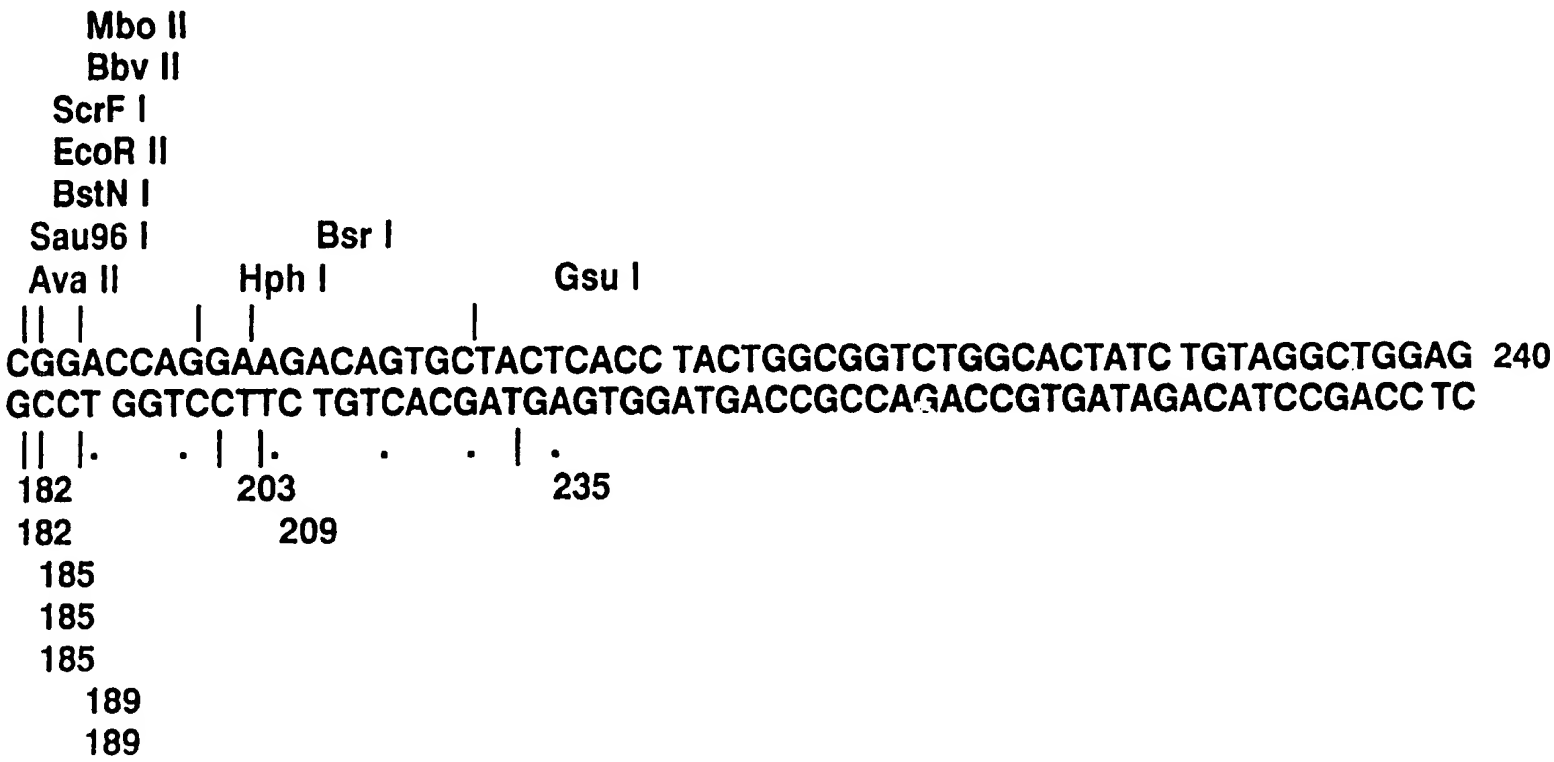

FIG. 2B (1)

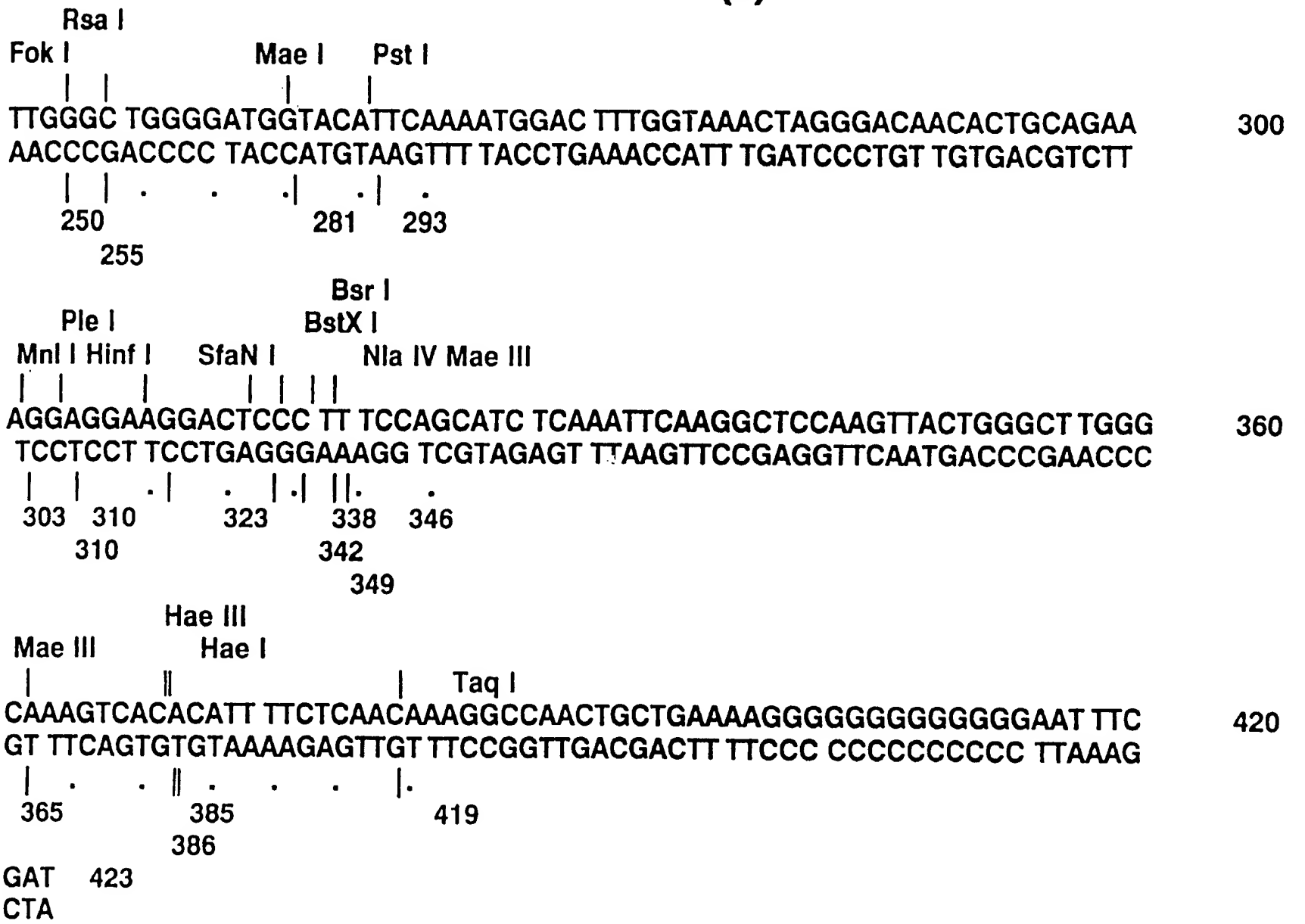

FIG. 2B (2)

Restriction Endonucleases site usage

Aat II	-	BstN I	2	HinC II	-	Ple I	1
Acc I	-	BstU I	-	HinD III	-	Pml I	-
Afl II	-	BstX I	1	Hinf I	1	PpuM I	1
Afl III	-	BstY I	-	HinP I	-	Pst I	1
Aha II	-	Bsu36 I	-	Hpa I	-	Pvu I	-
Alu I	2	Cfr10 I	-	Hpa II	1	Pvu II	-
Alw I	-	Cla I	-	Hph I	1	Rsa I	1
AlwN I	-	Dde I	-	Kpn I	-	Rsr II	-
Apa I	1	Dpn I	-	Mae I	3	Sac I	-
ApaL I	-	Dra I	1	Mae II	1	Sac II	-
Ase I	-	Dra III	-	Mae III	2	Sal I	-
Asp718	-	Drd I	-	Mbo I	-	Sau3AI	-
Ava I	-	Dsa I	-	Mbo II	1	Sau96 I	5
Ava II	3	Eae I	-	Mlu I	-	Sca I	-
Avr II	-	Eag I	-	Mme I	-	ScrF I	2
BamH I	-	Ear I	-	Mnl I	1	Sec I	1
Ban I	-	Eco47 III	-	Msc I	-	SfaN I	1
Ban II	1	Eco57 I	-	Mse I	1	Sfi I	-
Bbe I	-	EcoN I	-	Msp I	1	Sma I	-
Bbv I	-	EcoO109 I	2	Nae I	-	SnaB I	-
Bbv II	1	EcoR I	-	Nar I	-	Spe I	-
Bcl I	-	EcoR II	2	Nci I	-	Sph I	-
Bcn I	-	EcoR V	-	Nco I	-	Spl I	-
Bgl I	-	Esp I	-	Nde I	1	Ssp I	-
Bgl II	-	Fnu4H I	-	Nhe I	-	Stu I	-
BsaA I	1	Fok I	1	Nla III	-	Sty I	1
Bsm I	-	Fsp I	-	Nla IV	3	Taq I	1
BsmA I	1	Gdi II	-	Not I	-	Tth111 I	-
Bsp 1286 I	1	Gsu I	1	Nru I	-	Tth111 II	-
BspH I	-	Hae I	3	Nsi I	-	Xba I	-
BspM I	-	Hae II	-	Nsp7524 I	-	Xea I	-
BspM II	1	Hae III	4	NspB II	-	Xho I	-
Bsr I	2	Hga I	-	NspH I	-	Xcm I	-
BssH II	-	HgiA I	-	PaeR7 I	-	Xma I	-
BstB I	-	HgiE II	-	PflM I	-	Xmn I	-
BstE II	-	Hha I	-				

FIG. 2C (1)

Enzyme	Site	Use	Site	Position	Fragment Length	Fragment Order
Apa I	gggcc/c		1	1	3	2
				4	420	1
Ban II	grgcy/c		1	1	3	2
				4	420	1
Bbv II	gaagac	2/6	1	1	188	2
				189	235	1
BsaA I	yac/gtr		1	1	80	2
				81	343	1
BsmA I	gtctc	1/5	1	1	123	2
				124	300	1
Bsp1286 I	gdgch/c		1	1	3	2
				4	420	1
BspM II	t/ccgga		1	1	178	2
				179	245	1
BstX I	ccannnnn/ntgg		1	1	341	1
				342	82	2
Dra I	ttt/aaa		1	1	35	2
				36	388	1
Fok I	ggatg	9/13	1	1	249	1
				250	174	2
Gsu I	ctggag	16/14	1	1	234	1
				235	189	2
Hinf I	g/antc		1	1	309	1
				310	114	2
Hpa II	c/cgg		1	1	179	2
				180	244	1
Hph I	ggtga	8/7	1	1	202	2
				203	221	1
Mae II	a/cgt		1	1	81	2
				82	342	1
Mbo II	gaaga	8/7	1	1	188	2
				189	235	1
Mnl I	cctc	7/7	1	1	302	1
				303	121	2
Mse I	t/taa		1	1	36	2
				37	387	1
Msp I	c/cgg		1	1	179	2
				180	244	1
Nde I	ca/tatg		1	1	88	2
				89	335	1

FIG. 2C (2)

Enzyme	Site	Use	Site	Position	Fragment Length	Fragment Order
Ple I	gagtc	4/5	1	1	309	1
				310	114	2
PpuM I	rg/gwccy		1	1	153	2
				154	270	1
Pst I	ctgca/g		1	1	292	1
				293	131	2
Rsa I	gt/ac		1	1	254	1
				255	169	2
Sec I	c/cnngg		1	1	73	2
				74	350	1
SfaN I	gcatc	5/9	1	1	322	1
				323	101	2
Sty I	c/cwwgg		1	1	73	2
				74	350	1
Taq I	t/cga		1	1	418	1
				419	5	2
Alu I	ag/ct		2	1	99	2
				100	12	3
				112	312	1
BsrI	actgg	1/-1	2	1	208	1
				209	140	2
				349	75	3
Bstn I	cc/wgg		2	1	133	2
				134	51	3
				185	239	1
EcoO109 I	rg/gnccy		2	1	3	3
				4	150	2
				154	270	1
EcoR II	/ccwgg		2	1	133	2
				134	51	3
				185	239	1
Mae III	/gtnac		2	1	345	1
				346	19	3
				365	59	2
ScrFI	cc/ngg		2	1	133	2
				134	51	3
				185	239	1

FIG. 2C (3)

Enzyme	Site	Use	Site	Position	Fragment Length	Fragment Order
Ava II	g/gwcc		3	1	154	2
				155	22	3
				177	5	4
				182	242	1
Hae I	wgg/ccw		3	1	76	2
				77	59	3
				136	249	1
				385	39	4
Mae I	c/tag		3	1	144	1
				145	29	4
				174	107	3
				281	143	2
Nla IV	ggn/ncc		3	1	3	3
				4	1	4
				5	333	1
				338	86	2
Hae III	gg/cc		4	1	4	5
				5	73	2
				78	59	3
				137	249	1
				386	38	4
Sau 96 I	g/gncc		5	1	3	5
				4	1	6
				5	150	2
				155	22	3
				177	5	4
				182	242	1

63 sites found

FIG. 3

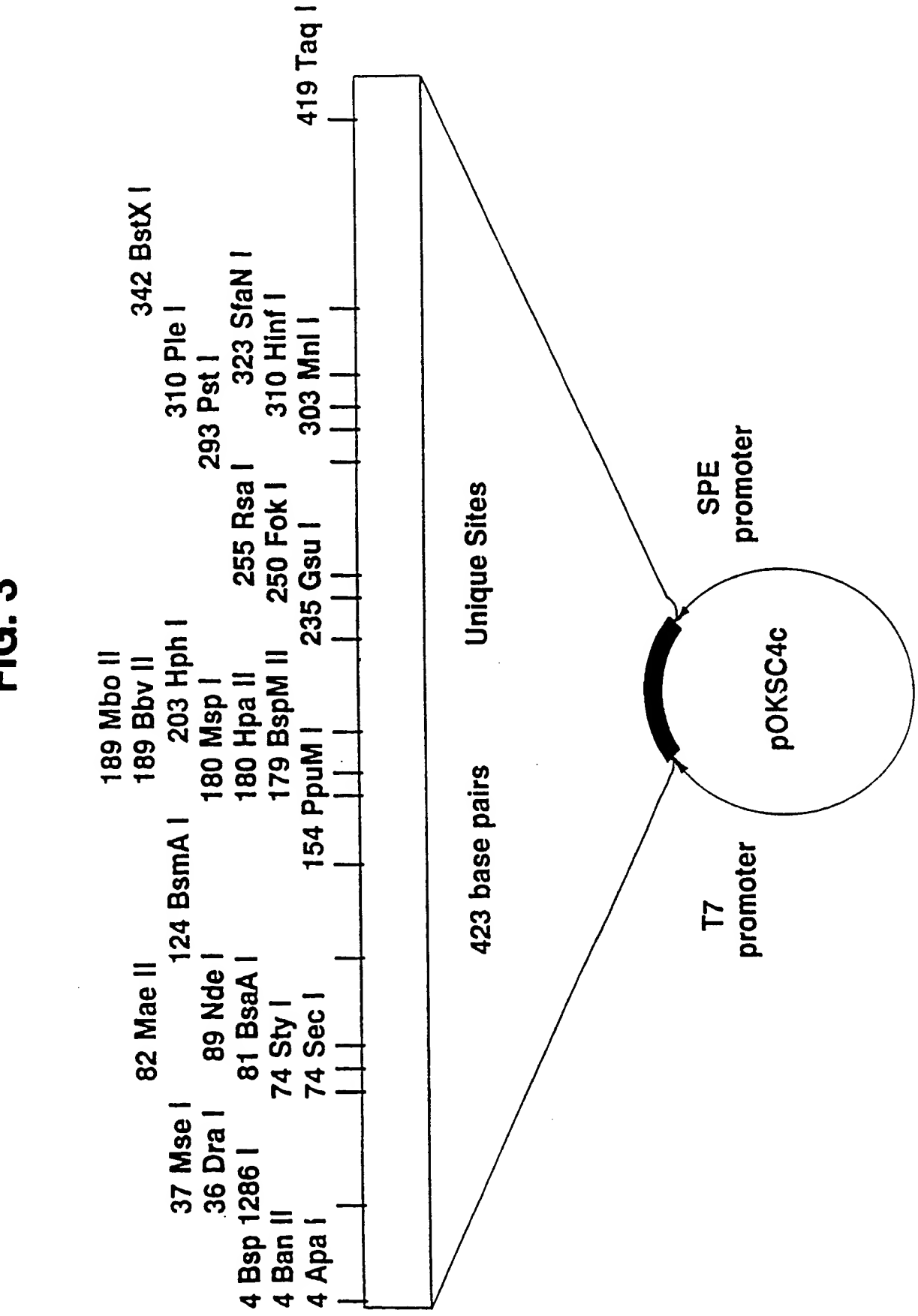

FIG. 4

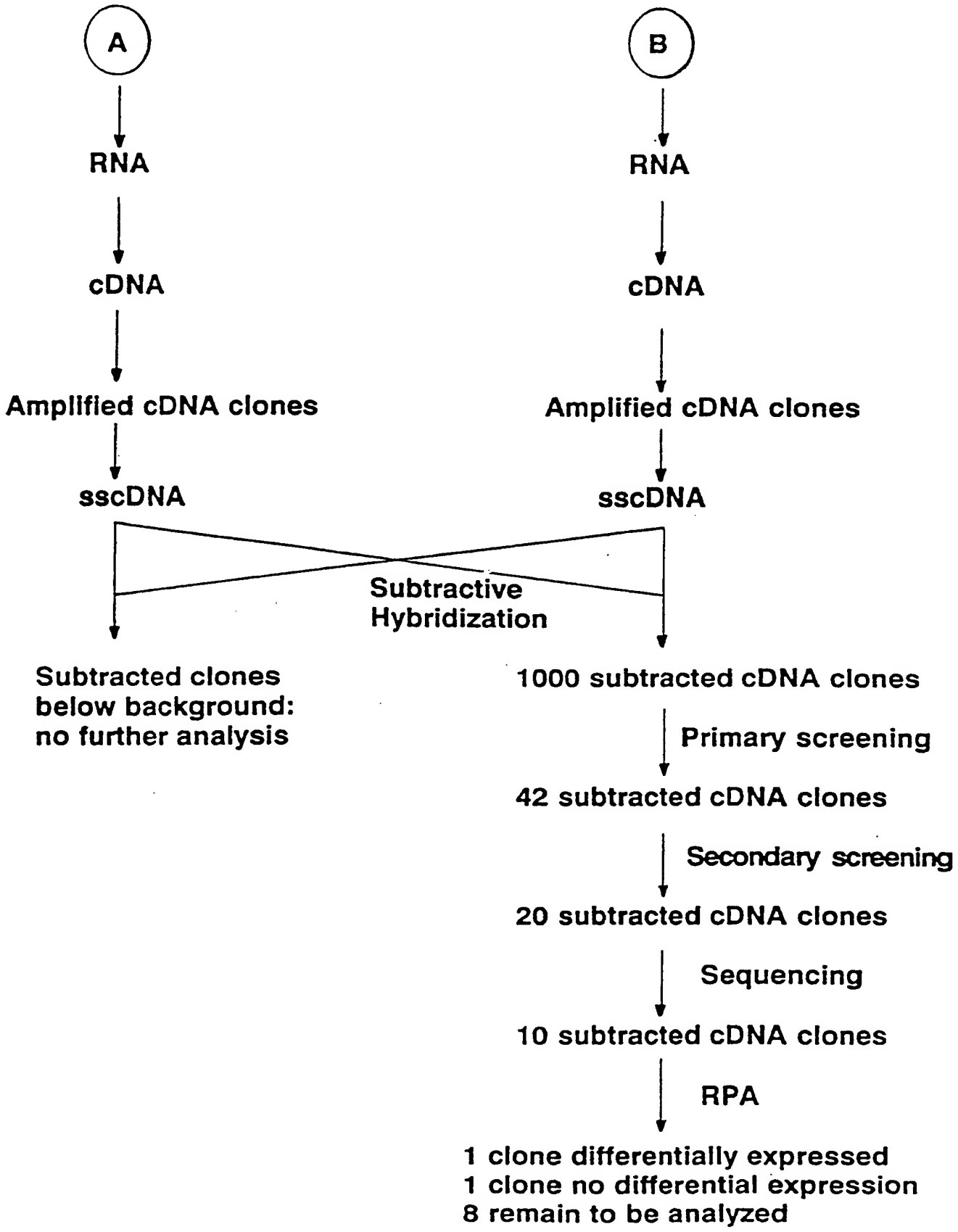
A
B
RNA
RNA
cDNA
cDNA
Amplified cDNA clones
Amplified cDNA clones
sscDNA
sscDNA
Subtractive Hybridization
Subtracted clones below background: no further analysis
1000 subtracted cDNA clones
Primary screening
42 subtracted cDNA clones
Secondary screening
20 subtracted cDNA clones
Sequencing
10 subtracted cDNA clones
RPA
1 clone differentially expressed
1 clone no differential expression
8 remain to be analyzed

FIG. 5A

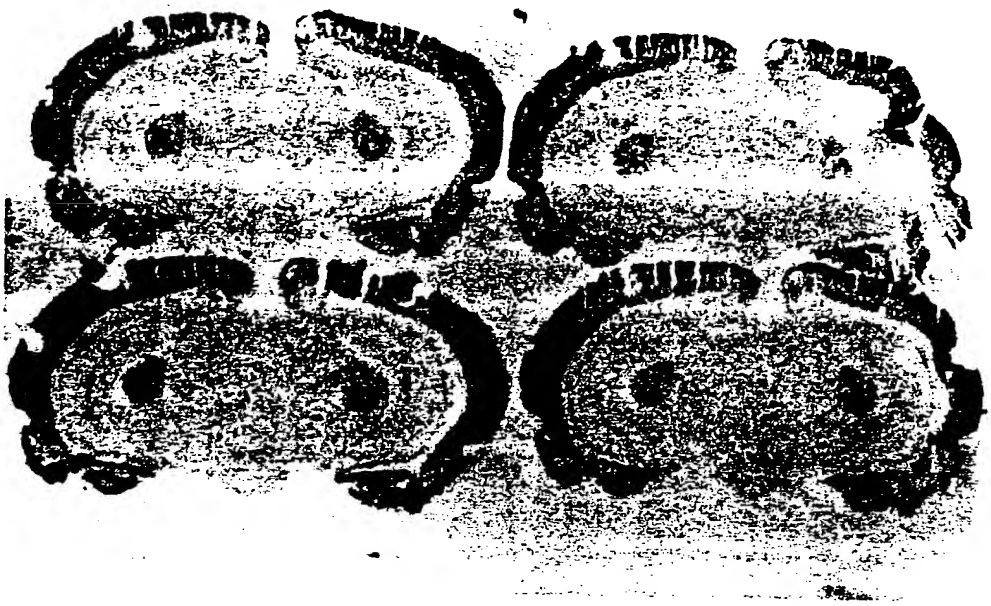

FIG. 5B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/05445

A. CLASSIFICATION OF SUBJECT MATTER
IPC(5) :Please See Extra Sheet.
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 435/6, 69.1, 172.1, 240.1, 320.1; 514/2, 44; 530/300, 350; 536/23.1, 23.5, 24.31

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, BIOSIS, EMBASE, CHEMICAL ABSTRACTS
search terms: psychosis protecting peptide or protein, psychosis, schizophrenia, protein, gene expression

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Schizophrenia Research, Volume 6, No. 3, issued 1992, C.W. Perrett et al, "Changes in brain gene expression in schizophrenic and depressed patients", pages 193-200, see the abstract.	1-6, 9-12, 16-19, 22-25, 30-32
Y	US, A, 5,089,397 (KUSHNER ET AL) 18 February 1992, see the entire document.	4-6, 9-12, 22-25, 30-32

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 AUGUST 1994	SEP 02 1994
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer BRUCE CAMPELL Telephone No. (703) 308-0196

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/05445

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
1-6, 9-12, 16-19, 22-25 and 30-32

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
[redacted]/US94/05445

A. CLASSIFICATION OF SUBJECT MATTER:
IPC (5):

A01N 37/18, 43/04; A61K 31/70, 37/00, 37/02; C07H 17/00; C07K 3/00, 13/00, 15/00, 17/00; C12N 5/00, 15/00; C12P 21/06; C12Q 1/68

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

435/6, 69.1, 172.1, 240.1, 320.1; 514/2, 44; 530/300, 350; 536/23.1, 23.5, 24.31

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

Group I, claims 1-6, 30 and 32, drawn to nucleic acid sequences encoding PP proteins, and methods of using said sequences to detect other PP protein encoding nucleic acid sequences.

Group II, claims 7-8, drawn to methods of isolating nucleic acids encoding PP proteins.

Group III, claims 9-12, 16-19, 22-25 and 31, drawn to PP proteins and methods for their production.

Group IV, claims 13-15, drawn to methods for amplifying PP protein nucleic acid sequences.

Group V, claims 20-21, drawn to methods of treatment for psychotic disorder.

Group VI, claim 26, drawn to a method of producing PP protein by chemical synthesis.

Group VII, claims 27-29, drawn to antibodies against PP proteins and methods for their use.

Group VIII, claims 33-38, drawn to transgenic animals containing antisense transgenes complementary to PP protein encoding genes.

The inventions listed as Groups I-VIII do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Inventions I and each of II and IV are related as product and process of use. The inventions are distinct because the product as claimed can be used for several different processes, as evidenced by the methods of inventions I, II and IV. Furthermore, the product of II (claim 8) encompasses nucleic acid sequences which are different from those of I, but similar enough to hybridize.

Inventions I and VIII are related as mutually exclusive species in intermediate-final product relationship. The inventions are distinct because the intermediate is also useful for the processes of II and IV, and there is nothing on the record to show I and VIII to be obvious variants.

Invention I is distinct from each of III and V-VII because the nucleic acids of I are not required for the production of the proteins or the methods of III and V-VII, and the proteins and methods of III and V-VII are not required for production of the nucleic acids of I.

Invention VIII is distinct from each of II-VII because the compositions and methods of II-VII are not required for production of the animals of VIII and the animals of VIII are not required for the compositions and methods of II-VII.

Inventions II and IV are distinct because each invention requires reagents and processes not required for the other.

Inventions II and III are related as product and process of use. The inventions are distinct because the process for producing PP protein can be practiced using materially different products, i.e. the amino acids used in the method of invention VI.

Invention II is distinct from each of V-VII because the method and product of II are not required for the methods and products of V-VII, and the methods and products of V-VII are not required for the method and product of II.

Inventions III and VI are distinct because they are two materially different methods for making PP proteins, the two methods requiring different reagents and procedures.

Inventions III and V are related as product and process of use. The inventions are distinct because psychotic disorders can be treated by administering any one of a number of known neuroleptic agents, such as those listed on page 3 of the description.

Inventions III and VII are distinct because the methods and cells of III are not required to produce the antibodies of VII. The antibodies of VII can be induced using the synthetic proteins of VI. The antibodies of VII are not required for the methods of III. Furthermore, each invention includes methods not required for the other invention.

Inventions IV-VII are distinct, each from the others, because they are drawn to divergent methods. Each method requires reagents and procedures not required for the other three methods, and yields different products or results. The methods of IV-VI are not required for production of the antibodies of VII, nor are the antibodies of VII required for the methods of IV-VI.

Accordingly, the claims are not so linked by a special technical feature within the meaning of PCT Rule 13.2 so as to form a single inventive concept.